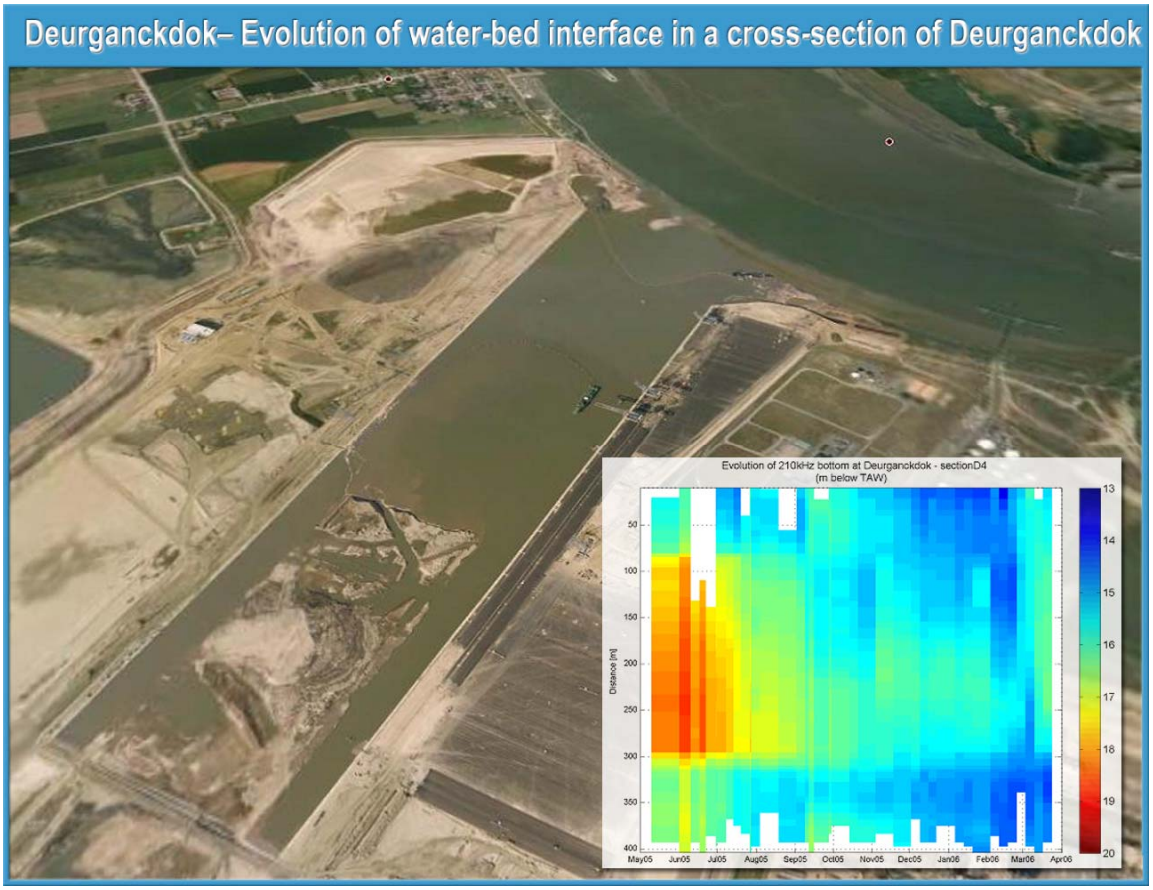
VLAAMSE OVERHEID

DEPARTEMENT MOBILITEIT EN OPENBARE WERKEN
WATERBOUWKUNDIG LABORATORIUM

Langdurige metingen Deurganckdok 2: Opvolging en analyse aanslibbing

Bestek 16EB/05/04



Deelrapport 1.20 : **Sedimentbalans 01/04/2008 – 30/06/2008**

Report 1.20 : **Sediment balance 01/04/2008 – 30/06/2008**

12 February 2009

I/RA/11283/08.076/MSA

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i.s.m.

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TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

BIS	Dredging Information System used in the Lower Sea Scheldt
d	Density of dredged sediment [kg/dm³]
DGD	Deurganckdok
HCBS	High Concentration Benthic Suspensions
M	mass of dry solids [ton]
ρ_s	density of the solid minerals [kg/dm³]
ρ_w	density of clear water [kg/dm³]
t_{0d}	Reference situation for densimetric analysis (empty dock)
t_{0e}	Reference situation for volumetric analysis (24 March 2006)
TDS	Ton of dry solids [ton]
V	volume of dredged sediment [m³]

1. INTRODUCTION

1.1. The assignment

This report is part of the set of reports describing the results of the long-term measurements conducted in Deurganckdok aiming at the monitoring and analysis of silt accretion. This measurement campaign is an extension of the study "Extension of the study about density currents in the Beneden Zeeschelde" as part of the Long Term Vision for the Scheldt estuary. It is complementary to the study 'Field measurements high-concentration benthic suspensions (HCBS 2)'.

The terms of reference for this study were prepared by the 'Departement Mobiliteit en Openbare Werken van de Vlaamse Overheid, Afdeling Waterbouwkundig Laboratorium' (16EB/05/04). The repetition of this study was awarded to International Marine and Dredging Consultants NV in association with WL|Delft Hydraulics and Gems International on 10/01/2006. The project term was repeated twice with an extra year from April 2007 till March 2008, and April 2008 till March 2009.

Waterbouwkundig Laboratorium– Cel Hydrometrie Schelde provided data on discharge, tide, salinity and turbidity along the river Scheldt and provided survey vessels for the long term and through tide measurements. Afdeling Maritieme Toegang provided maintenance dredging data. Agentschap voor Maritieme Dienstverlening en Kust – Afdeling Kust and Port of Antwerp provided depth sounding measurements.

The execution of the study involves a twofold assignment:

- Part 1: Setting up a sediment balance of Deurganckdok covering a period of one year, i.e. 04/2008 – 03/2009
- Part 2: An analysis of the parameters contributing to siltation in Deurganckdok

1.2. Purpose of the study

The Lower Sea Scheldt (Beneden Zeeschelde) is the stretch of the Scheldt estuary between the Belgium-Dutch border and Rupelmonde, where the entrance channels to the Antwerp sea locks are located. The navigation channel has a sandy bed, whereas the shallower areas (intertidal areas, mud flats, salt marshes) consist of sandy clay or even pure mud sometimes. This part of the Scheldt is characterized by large horizontal salinity gradients and the presence of a turbidity maximum with depth-averaged concentrations ranging from 50 to 500 mg/l at grain sizes of 60 - 100 μm. The salinity gradients generate significant density currents between the river and the entrance channels to the locks, causing large siltation rates. It is to be expected that in the near future also the Deurganckdok will suffer from such large siltation rates, which may double the amount of dredging material to be dumped in the Lower Sea Scheldt.

Results from the study may be interpreted by comparison with results from the HCBS and HCBS2 studies covering the whole Lower Sea Scheldt. These studies included through-tide measurement campaigns in the vicinity of Deurganckdok and long term measurements of turbidity and salinity in and near Deurganckdok.

The first part of the study focuses on obtaining a sediment balance of Deurganckdok. Aside from natural sedimentation, the sediment balance is influenced by the maintenance and capital dredging works. This involves sediment influx from capital dredging works in the Deurganckdok, and internal relocation and removal of sediment by maintenance dredging works. To compute a sediment balance an inventory of bathymetric data (depth soundings), density measurements of the

deposited material and detailed information of capital and maintenance dredging works will be made up.

The second part of the study is to gain insight in the mechanisms causing siltation in Deurganckdok, it is important to follow the evolution of the parameters involved, and this on a long and short term basis (long term & through-tide measurements). Previous research has shown the importance of water exchange at the entrance of Deurganckdok is essential for understanding sediment transport between the dock and the Scheldt river.

1.3. Overview of the reports

1.3.1. Reports

Reports of the project 'Opvolging aanslibbing Deurganckdok' and 'Opvolging aanslibbing Deurganckdok 2' for the period April 2006 – March 2008 are summarized in Table 1-1.

Table 1-1: Overview of Deurganckdok Reports

Report	Description
Sediment Balance: Bathymetry surveys, Density measurements, Maintenance and construction dredging activities	
1.1	Sediment Balance: Three monthly report 1/4/2006 – 30/06/2006 (I/RA/11283/06.113/MSA)
1.2	Sediment Balance: Three monthly report 1/7/2006 – 30/09/2006 (I/RA/11283/06.114/MSA)
1.3	Sediment Balance: Three monthly report 1/10/2006 – 31/12/2006 (I/RA/11283/06.115/MSA)
1.4	Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.116/MSA)
1.5	Annual Sediment Balance (I/RA/11283/06.117/MSA)
1.6	Sediment balance Bathymetry: 2005 – 3/2006 (I/RA/11283/06.118/MSA)
1.10	Sediment Balance: Three monthly report 1/4/2007 - 30/06/2007(I/RA/11283/07.081/MSA)
1.11	Sediment Balance: Two monthly report 1/7/2007 – 31/08/2007 (I/RA/11283/07.082/MSA)
1.12	Sediment Balance: Four monthly report 1/09/2007 – 31/12/2007 (I/RA/11283/07.083/MSA)
1.13	Sediment Balance: Three monthly report 1/1/2008 – 31/03/2008 (I/RA/11283/07.084/MSA)
1.14	Annual Sediment Balance (I/RA/11283/07.085/MSA)
1.20	Sediment Balance: Three monthly report 1/4/2008 - 30/6/2008 (I/RA/11283/08.076/MSA)
1.21	Sediment Balance: Three monthly report 1/7/2008 – 30/9/2008

Report	Description
	(I/RA/11283/08.077/MSA)
1.22	Sediment Balance: Three monthly report 1/10/2008 – 31/12/2008 (I/RA/11283/08.078/MSA)
1.23	Sediment Balance: Three monthly report 1/1/2009 – 31/03/2009 (I/RA/11283/08.079/MSA)
1.24	Annual Sediment Balance (I/RA/11283/08,080/MSA)
Factors contributing to salt and sediment distribution in Deurganckdok: Salt-Silt (OBS3A) & Frame measurements, Through tide measurements (SiltProfiling & ADCP) & Calibrations	
2.1	Through tide measurement Siltprofiler 21/03/2006 Laure Marie (I/RA/11283/06.087/WGO)
2.2	Through tide measurement Siltprofiler 26/09/2006 Stream (I/RA/11283/06.068/MSA)
2.3	Through tide measurement Sediview spring tide 22/03/2006 Veremans (I/RA/11283/06.110/BDC)
2.4	Through tide measurement Sediview spring tide 27/09/2006 Parel 2 (I/RA/11283/06.119/MSA)
2.5	Through tide measurement Sediview neap tide (to be scheduled) (I/RA/11283/06.120/MSA)
2.6	Salinity-Silt distribution & Frame Measurements Deurganckdok 13/3/2006 – 31/05/2006 (I/RA/11283/06.121/MSA)
2.7	Salinity-Silt distribution & Frame Measurements Deurganckdok 15/07/2006 – 31/10/2006 (I/RA/11283/06.122/MSA)
2.8	Salinity-Silt distribution & Frame Measurements Deurganckdok 15/01/2007 – 15/03/2007 (I/RA/11283/06.123/MSA)
2.9	Calibration stationary equipment autumn (I/RA/11283/07.095/MSA)
2.10	Through tide measurement Siltprofiler winter (I/RA/11283/07.086/MSA)
2.11	Through tide measurement Salinity Profiling winter (I/RA/11283/07.087/MSA)
2.12	Through tide measurement Sediview winter (I/RA/11283/07.088/MSA)
2.13	Through tide measurement Sediview winter (I/RA/11283/07.089/MSA)
2.14	Through tide measurement Sediview winter (I/RA/11283/07.090/MSA)
2.15	Through tide measurement Siltprofiler (to be scheduled) (I/RA/11283/07.091/MSA)
2.16	Salt-Silt distribution Deurganckdok summer (21/6/2007 – 30/07/2007) (I/RA/11283/07.092/MSA)
2.17	Salt-Silt distribution & Frame Measurements Deurganckdok autumn (17/09/2007 - 10/12/2007) (I/RA/11283/07.093/MSA)
2.18	Salt-Silt distribution & Frame Measurements Deurganckdok winter (18/02/2008 - 31/3/2008) (I/RA/11283/07.094/MSA)

Report	Description
2.19	Calibration stationary & mobile equipment winter (I/RA/11283/07.096/MSA)
2.20	Through tide measurement Sediview DGD during neap tide Spring 2008 (I/RA/11283/08.081/MSA)
2.21	Through tide measurement Sediview DGD during spring tide Spring 2008 (I/RA/11283/08.082/MSA)
2.22	Through tide measurement Sediview DGD during neap tide Summer 2008 (I/RA/11283/08.083/MSA)
2.23	Through tide measurement Sediview DGD during spring tide Summer 2008 (I/RA/11283/08.084/MSA)
2.24	Through tide measurement Sediview DGD during neap tide Autumn 2008 (I/RA/11283/08.085/MSA)
2.25	Through tide measurement Sediview DGD during spring tide Autumn 2008 (I/RA/11283/08.086/MSA)
2.26	Through tide measurement Sediview DGD during neap tide Winter 2009 (I/RA/11283/08.087/MSA)
2.27	Through tide measurement Sediview DGD during spring tide Winter 2009 (I/RA/11283/08.088/MSA)
2.28	Through tide measurement ADCP eddy DGD Summer 2008 (I/RA/11283/08.089/MSA)
2.29	Through tide measurement Siltprofiler DGD Summer 2008 (I/RA/11283/08.090/MSA)
2.30	Through tide measurement Siltprofiler DGD Winter 2009 (I/RA/11283/08.091/MSA)
2.31	Through tide measurement Salinity Profiling DGD Winter 2009 (I/RA/11283/08.092/MSA)
2.32	Salt-Silt distribution Deurganckdok: Six monthly report 1/4/2008 - 30/9/2008 (I/RA/11283/08.093/MSA)
2.33	Salt-Silt distribution Deurganckdok: Six monthly report 1/10/2008 – 31/3/2009 (I/RA/11283/08.094/MSA)
2.34	Calibration stationary & mobile equipment Autumn 2008 (I/RA/11283/08.095/MSA)
Boundary Conditions: Upriver Discharge, Salt concentration Scheldt, Bathymetric evolution in access channels, dredging activities in Lower Sea Scheldt and access channels	
3.1	Boundary conditions: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.127/MSA)
3.10	Boundary conditions: Three monthly report 1/4/2007 – 30/06/2007 (I/RA/11283/07.097/MSA)
3.11	Boundary conditions: Three monthly report 1/7/2007 – 30/09/2007 (I/RA/11283/07.098/MSA)
3.12	Boundary conditions: Three monthly report 1/10/2007 – 31/12/2007 (I/RA/11283/07.099/MSA)

Report	Description
3.13	Boundary conditions: Three monthly report 1/1/2008 – 31/03/2008 (I/RA/11283/07.100/MSA)
3.14	Boundary conditions: Annual report (I/RA/11283/07.101/MSA)
3.20	Boundary conditions: Six monthly report 1/4/2008 – 30/09/2008 (I/RA/11283/08.096/MSA)
3.21	Boundary conditions: Six monthly report 1/10/2008 – 31/03/2009 (I/RA/11283/08.097/MSA)
Analysis	
4.1	Analysis of Siltation Processes and Factors (I/RA/11283/06.129/MSA)
4.10	Analysis of Siltation Processes and Factors (I/RA/11283/07.102/MSA)
4.20	Analysis of Siltation Processes and Factors (I/RA/11283/08.098/MSA)

1.3.2. Measurement actions

Following measurements have been carried out during the course of this project:

1. Monitoring upstream discharge in the Scheldt river
2. Monitoring Salt and sediment concentration in the Lower Sea Scheldt taken from on permanent data acquisition sites at Lillo, Oosterweel and up- and downstream of the Deurganckdok.
3. Long term measurement of salt distribution in Deurganckdok.
4. Long term measurement of sediment concentration in Deurganckdok
5. Monitoring near-bed processes in the central trench in the dock, near the entrance as well as near the landward end: near-bed turbidity, near-bed current velocity and bed elevation variations are measured from a fixed frame placed on the dock's bed.
6. Measurement of current, salt and sediment transport at the entrance of Deurganckdok for which ADCP backscatter intensity over a full cross section are calibrated with the Sediview procedure and vertical sediment and salt profiles are recorded with the SiltProfiler equipment
7. Through tide measurements of vertical sediment concentration profiles -including near bed highly concentrated suspensions- with the SiltProfiler equipment. Executed over a grid of points near the entrance of Deurganckdok.
8. Monitoring dredging activities at entrance channels towards the Kallo, Zandvliet and Berendrecht locks
9. Monitoring dredging and dumping activities in the Lower Sea Scheldt

In situ calibrations were conducted to calibrate all turbidity and conductivity sensors (IMDC, 2006f & IMDC, 2007l).

1.4. Structure of the report

This report is the sediment balance of the Deurganckdok for the period of 01/04/2008 to 30/06/2008. The first chapter comprises an introduction. The second chapter describes the project. Chapter 3 describes the methodology. The measurement results and processed data are presented in Chapter 4, whereas chapter 5 gives a preliminary analysis of the data.

2. SEDIMENTATION IN DEURGANCKDOK

2.1. Project Area: Deurganckdok

Deurganckdok is a tidal dock situated at the left bank in the Lower Sea Scheldt, between Liefkenshoek and Doel. Deurganckdok has the following characteristics:

1. The dock has a total length of 2750 m and is 450 m wide at the Scheldt end and 400 m wide at the inward end of the dock
2. The bottom of Deurganckdok is provided at a depth of –17m TAW in the transition zones between the quay walls and the central trench. The bottom in the central trench is designed at –19 m TAW.
3. The quay walls reach up to +9m TAW

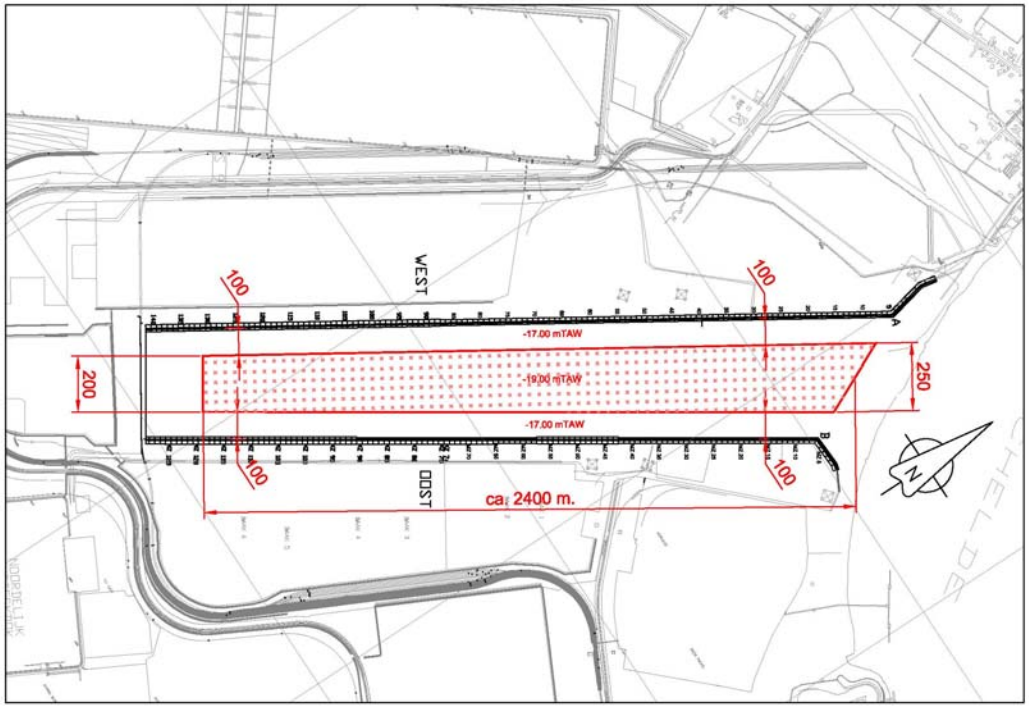


Figure 2-1: Overview of Deurganckdok

The dredging of the dock is performed in 3 phases. On 18 February 2005 the dike between the Scheldt and the Deurganckdok was breached. On 6 July 2005 Deurganckdok was officially opened. The second dredging phase was finalized a few weeks later. The first terminal operations have started since. In February 2007, the third dredging phase started and is finalised by February 2008.

2.2. Overview of the studied parameters

The first part of the study aims at determining a sediment balance of Deurganckdok and the net influx of sediment. The sediment balance comprises a number of sediment transport modes: deposition, influx from capital dredging works, internal replacement and removal of sediments due to maintenance dredging (Figure 2-2).

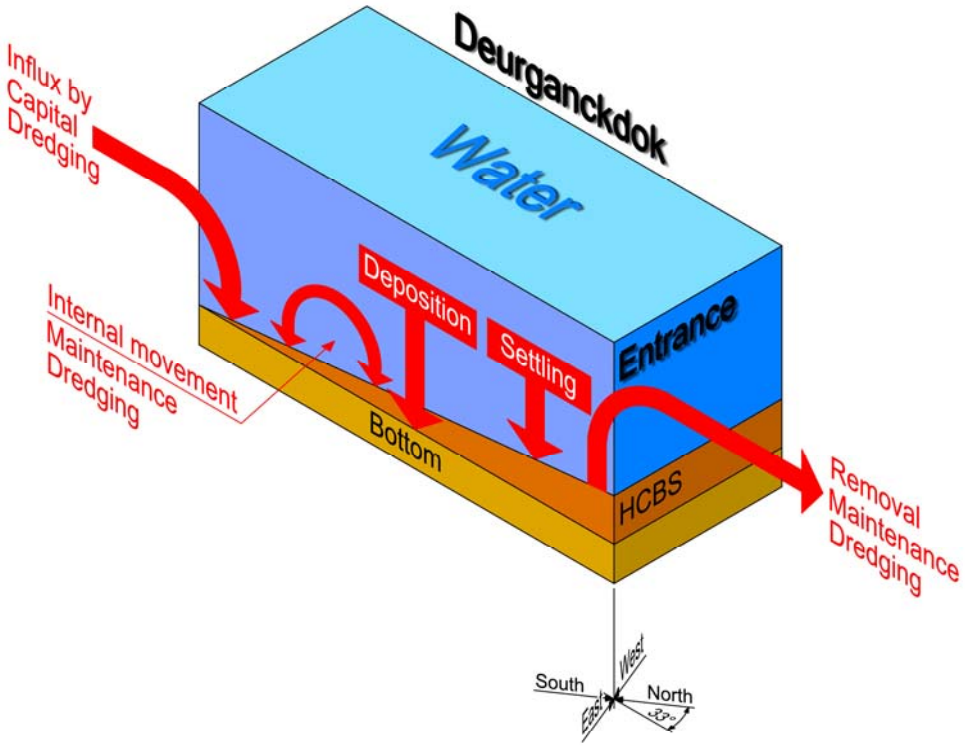


Figure 2-2: Elements of the sediment balance

A net deposition can be calculated from a comparison with a chosen initial condition t_0 (Figure 2-3). The mass of deposited sediment is determined from the integration of bed density profiles recorded at grid points covering the dock. Subtracting bed sediment mass at t_0 leads to the change in mass of sediments present in the dock (mass growth). Adding cumulated dry matter mass of dredged material removed since t_0 and subtracting any sediment influx due to capital dredging works leads to the total cumulated mass entered from the Scheldt river since t_0.

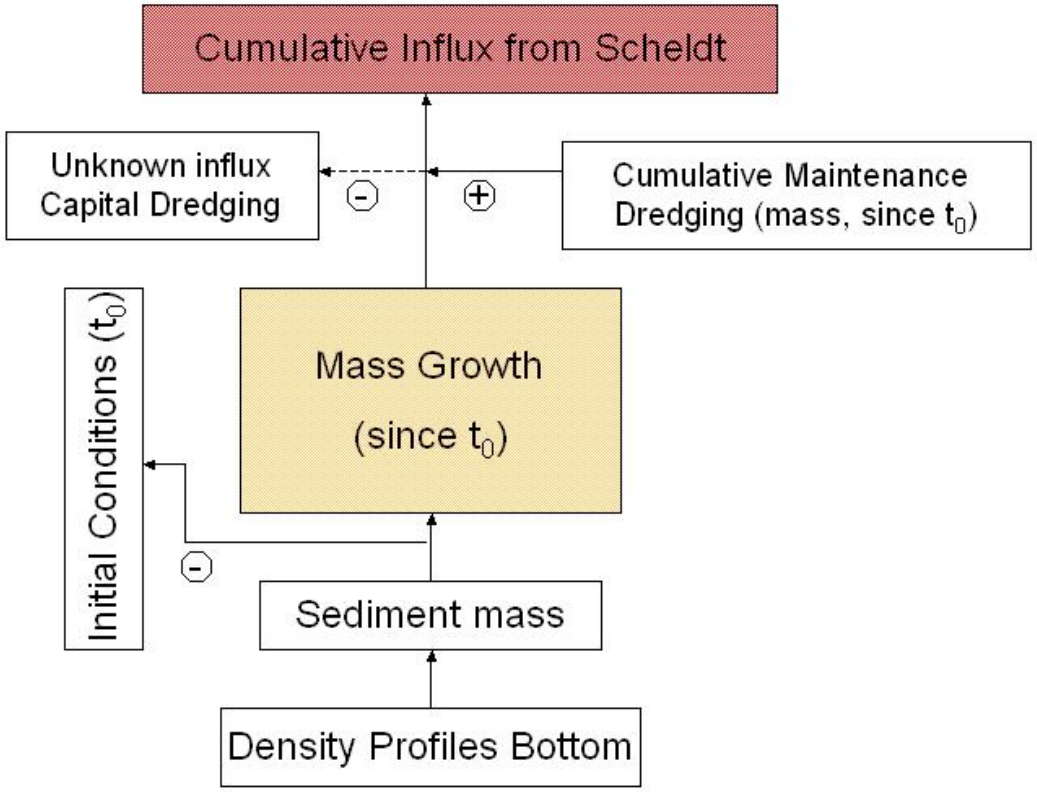


Figure 2-3: Determining a sediment balance

The main purpose of the second part of the study is to gain insight in the mechanisms causing siltation in Deurganckdok. The following mechanisms will be aimed at in this part of the study:

- Tidal prism, i.e. the extra volume in a water body due to high tide
- Vortex patterns due to passing tidal current
- Density currents due to salt gradient between the Scheldt river and the dock
- Density currents due to highly concentrated benthic suspensions

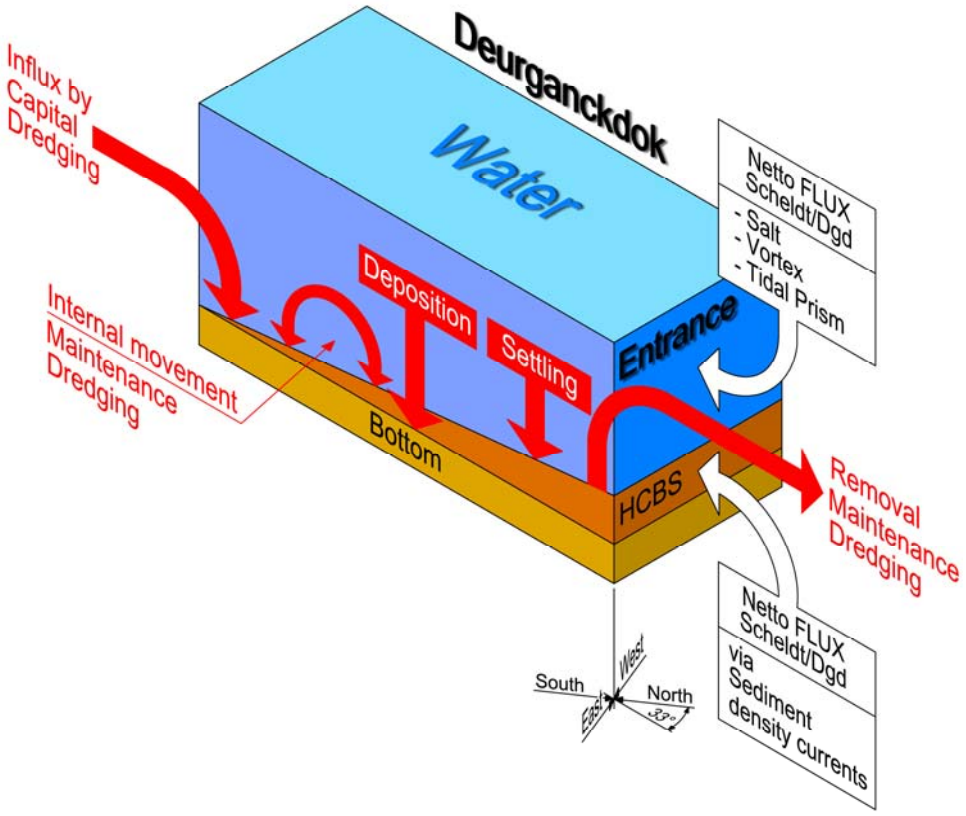


Figure 2-4: Transport mechanisms

These aspects of hydrodynamics and sediment transport have been landmark in determining the parameters to be measured during the project. Measurements will be focused on three types of timescales: one tidal cycle, one neap-spring cycle and seasonal variation within one year.

Following data are being collected to understand these mechanisms:

- Monitoring upstream discharge in the Scheldt river.
- Monitoring Salt and sediment concentration in the Lower Sea Scheldt at permanent measurement locations at Oosterweel, up- and downstream of the Deurganckdok.
- Long term measurement of salt and suspended sediment distribution in Deurganckdok.
- Monitoring near-bed processes (current velocity, turbidity, and bed elevation variations) in the central trench in the dock, near the entrance as well as near the current deflecting wall location.
- Dynamic measurements of current, salt and sediment transport at the entrance of Deurganckdok.
- Through tide measurements of vertical sediment concentration profiles -including near bed high concentrated benthic suspensions.
- Monitoring dredging activities at entrance channels towards the Kallo, Zandvliet and Berendrecht locks as well as dredging and dumping activities in the Lower Sea Scheldt.
- In situ calibrations were conducted on several dates to calibrate all turbidity and conductivity sensors.

3. MEASUREMENTS

3.1. Depth soundings

The client executes dual-frequency echo-sounder measurements every week to every three weeks. F. De Cock (Agentschap voor Maritieme Dienstverlening en Kust – Afdeling Kust) communicated that these measurements are carried out with a 210-33 kC Echo sounder using Qinsy software. The depth sounding measurements are executed in a grid configuration, consisting of sections perpendicular and parallel to the quay wall.

Table 3-1: Overview of the available depth soundings suitable for analysis 01/04/2008 – 30/06/2008

date	***type of measurement***	***signal***	***Source***
13/03/2008*	dual frequency 210-33 kHz	210	Afdeling Kust
11/04/2008	dual frequency 210-33 kHz	210	Afdeling Kust
9/05/2008	dual frequency 210-33 kHz	210	Afdeling Kust
4/06/2008	dual frequency 210-33 kHz	210	Afdeling Kust

*= reference situation depth soundings: t_{0e}

To calculate a sediment balance it is necessary to analyse the measurements in stationary situation, with no alteration in boundary conditions being dredging operations. Every period is characterized by a depth sounding measurement before ('inpeiling') and one after ('uitpeiling').

A number of analyses were done using the depth soundings in Table 3-1. The raw depth sounding data was processed in ESRI ArcGIS. The 210 kC signal is used in the following analyses as it gives an indication of the water-bed interface.

A reference level was chosen from all depth sounding measurements. Previous reports used the earliest measurement as reference level, i.e. 24 March 2006. In February 2008, the capital dredging of the dock was finalized such that a significant larger measurement area became applicable. A new reference situation, initial condition t_{0e}, therefore seemed plausible for which the depth sounding of 13 March 2008 was selected.

A number of analyses were performed in ArcGIS 9 and a Matlab environment to produce maps, figures and tables with relevant information concerning elevation, elevation changes and volumetric growth (§4.2 to §4.4).

3.2. Density measurements

Navitracker was used to perform density measurements. Density measurements are necessary to calculate a sediment balance of dry weight of sediment per surface unit.

The Navitracker is a patented system to measure the density of fluid mud suspensions, by means of a gamma-density meter. It has been used by the Flemish authorities over 20 years to determine the nautical bed for the port of Zeebrugge.

The Navitracker system can be operated by a computer controlled winch to tow it through the mud (horizontal mode). The Navitracker is equipped with the following sensors:

- The Gamma ray density sensor, mounted on a fork-like tow fish, gives density information.
- The depth sensor gives information of the depth of the sensor.
- The position of the fish is calculated out of the length of the winch cable. Together with the position of the tow fish, following the density level, a dual frequency echo sounder is used to

map the hard bottom and the top of the mud. With a speed of 2 to 3 knots, large areas can be covered.

For these measurements the Navitracker was used in a vertical profiling mode, with the probe in vertical position in order to penetrate the soft bottom. The vertical density profiler is used to measure density in thick mud layers with high densities.

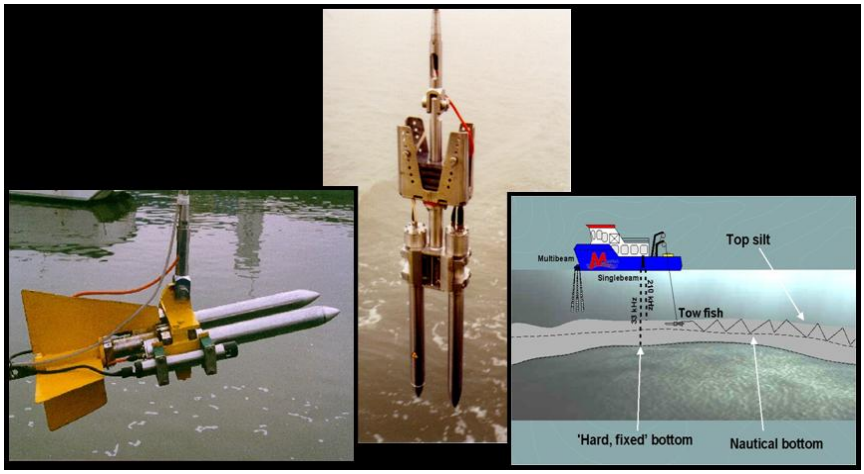


Figure 3-1: Navitracker

The Navitracker was calibrated in the laboratory for measuring high densities, formed by very dense water-mud mixtures. For this reason the Navitracker did not detect subtle variations in density caused by changes in salinity. The density deviated from 1.000 ton/m³ only in the presence of a high concentration of sediments.

The Navitracker has a sampling frequency of 10 measurements per second.

As a reference situation the empty dock will be used at the design depth. The design depths for the different zones are shown in Table 3-2. The different zones are described in §4.1.

Table 3-2: Reference Situation Density Measurements (t_{0d})

Zone	***Design Depth (mTAW)***
Central trench	-19
Berthing zones and transition zones to central trench	-17
Sill	-13.5
Transition sill to navigation channel	Not applicable

The resulting profiles were processed in a Matlab environment and visualized in Matlab and ESRI ArcGIS. Equal density layers were computed. Volume and density information was used to calculate masses of silt. All masses are given in ton of dry solids (TDS) characterized by a density of 2.65 kg/dm³. The water-bed interface is defined as the layer with a density of 1.03 kg/dm³.

In this measurement campaign, Navitracker density measurements have been performed on 28 April and 5 June 2008.

3.3. Maintenance Dredging Data

All maintenance dredging (except sweep beam) activities in Deurganckdok were collected in the BIS-system. This system gives a standardised output per week, that states the weight, volume and V'[1] removed/dumped in every 5*5m grid cell in the area. In case the density of the dredged sediment in the hopper bin is larger or equal to 1.6 kg/dm³, V' is equal to the volume in the bin. In case the density is smaller than 1.6 kg/dm³, V' is equal to the reduced volume which is defined as the volume the dredged sediment would have in case the density would be equal to 2 kg/dm³ (AWZ 2000). These dredged volumes are important to have an overall view on the sediment balance. Maintenance dredging occurred in the second half of May.

The available data on sweep beam activity is not collected in the BIS-system. However, the mode of operation of the sweep beam is explained:

- On the sill (zone 1 & 2): the sediment is swept into the Lower Sea Scheldt
- Inside the dock: the sweep beam sweeps the berthing zones next to the quay walls and moves sediment into the central trench

Therefore an overview is given of where and when a sweep beam dredger was working in Deurganckdok (DGD) or on the sill of Deurganckdok (sill DGD).

Table 3-3: Sweep beam maintenance dredging activities in Deurganckdok and on the sill of Deurganckdok between April and June 2008 (source: Afdeling Maritieme Toegang)

From	***Till***	***Duration (days)***	***Location***
1/04/2008	5/04/2008	5	Commercial quays
7/04/2008	9/04/2008	3	Sill DGD + commercial quays
14/04/2008	16/04/2008	3	Sill DGD + sediment bump at 2/3'rd of the dock
21/04/2008	21/04/2008	1	Sill DGD + DGD
28/04/2008	28/04/2008	1	Sill DGD
5/05/2008	5/05/2008	1	Sill DGD
19/05/2008	20/05/2008	2	Sill DGD
26/05/2008	27/05/2008	2	Sill DGD
2/06/2008	2/06/2008	1	Sill DGD
23/6/2008	23/6/2008	1	Sill DGD
30/6/2008	30/6/2008	1	Sill DGD

An overview of the total dredged mass in all zones (BIS data) is provided in APPENDIX I. The sweep beam tracks are shown in APPENDIX J. The loggings of the sweep beam tracks show the position and depth of the rake. From the up-down position of the rake and the ship's direction, it is possible to identify whether the ship is sweeping sediment into the Scheldt or not.

[1] V' = Reduced Volume

4. SEDIMENT BALANCE ANALYSES

4.1. Project Area: (Sub)Zones and Sections

To calculate volumes and masses for the sediment balance of Deurganckdok it is necessary to subdivide it into 5 zones:

- Zone 1: Between the sill and the navigation channel in the Lower Sea Scheldt.
- Zone 2: Sill at entrance DGD designed at –13.5 m TAW.
- Zone 3: Central trench in DGD with a design depth at –19 m TAW (including slope to –17 m TAW)
- Zone 4: Transition between central trench and berthing zones with a design depth at –17.00 m TAW: on both (North (N) and South (Z)) sides of DGD (55 m wide).
- Zone 5: Berthing zones next to quay walls on both (North (N) and South (Z)) sides of DGD (40 m wide)

Zones 3, 4 and 5 are subdivided into subzones A, B, C, D and E. This is shown in Figure 4-1.

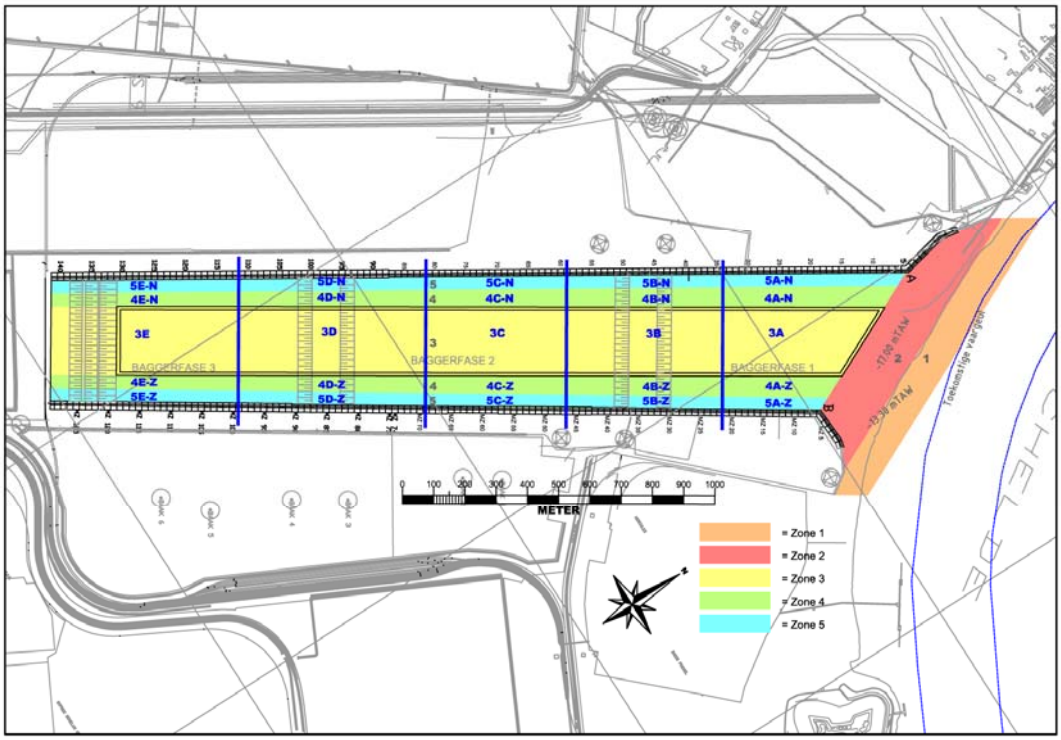


Figure 4-1: Deurganckdok: Zones and Subzones

Sections are defined for this whole area (Figure 4-2):

- D sections are oriented perpendicular to the quay walls inside the dock and parallel to the navigation channel outside the dock (sill and Scheldt). The origin of the sections is taken on the quay wall at the left bank (West side) looking outwards.
- L Sections are oriented along the centerline of the dock and run from the navigation channel towards the inland end of the dock, in anticipation of the realisation of the third phase of Deurganckdok. The origin is situated on the intersection between each L section and section D10.

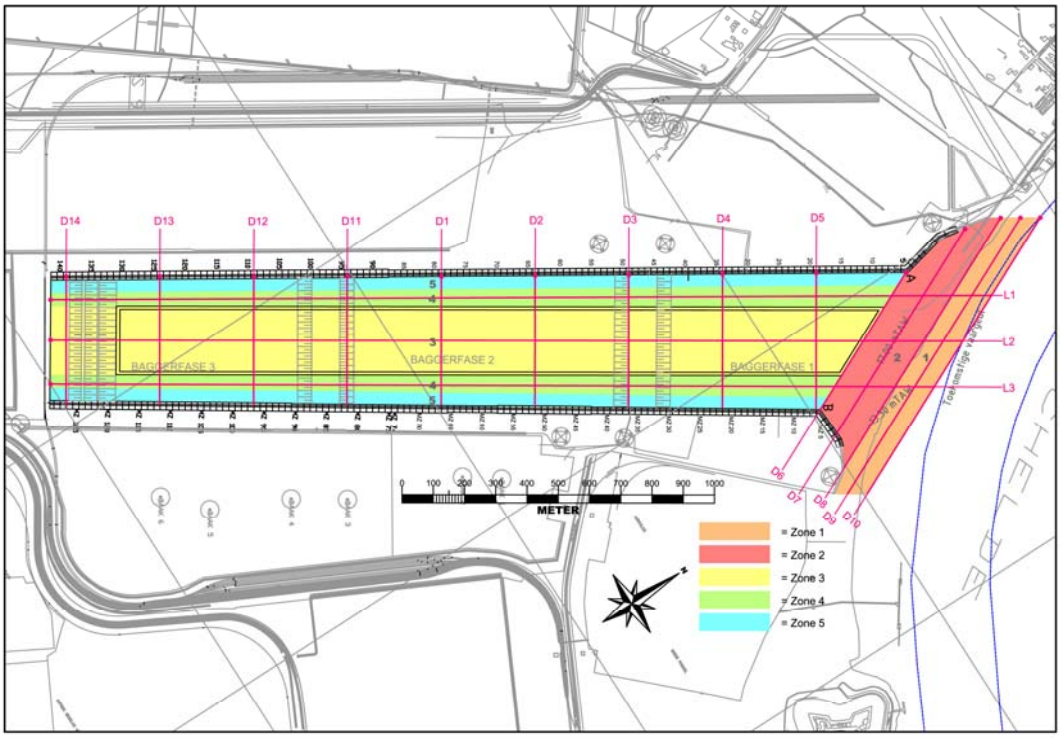


Figure 4-2: Deurganckdok: D and L Sections

The coordinates of these sections are given in Table 4-1.

Table 4-1: Coordinates of Sections [UTM ED50]

Name	***Origin***		***End***	
	Easting	***Northing***	***Easting***	***Northing***
D Sections				
D1	587773	5683253	588123	5683037
D2	587929	5683510	588283	5683290
D3	588084	5683767	588444	5683544
D4	588239	5684023	588604	5683797
D5	588394	5684280	588765	5684051
D6	588542	5684526	588772	5684062
D7	588521	5684761	588864	5684068
D8	588552	5684875	588972	5684027
D9	588585	5684930	589047	5683994
D10	588617	5684984	589081	5684047
D11	587615	5682997	587962	5682783
D12	587459	5682742	587802	5682529
D13	587300	5682487	587642	5682276
D14	587143	5682232	587482	5682023
L Sections				
L1	588748	5684720	587180	5682151
L2	588825	5684565	587290	5682082
L3	588901	5684410	587409	5682007

4.2. Depth of the water-bed interface (210 kC)

This is shown as a GIS grid map generated directly from the depth sounding data and is shown in APPENDIX A. An example is shown in Figure 4-3.

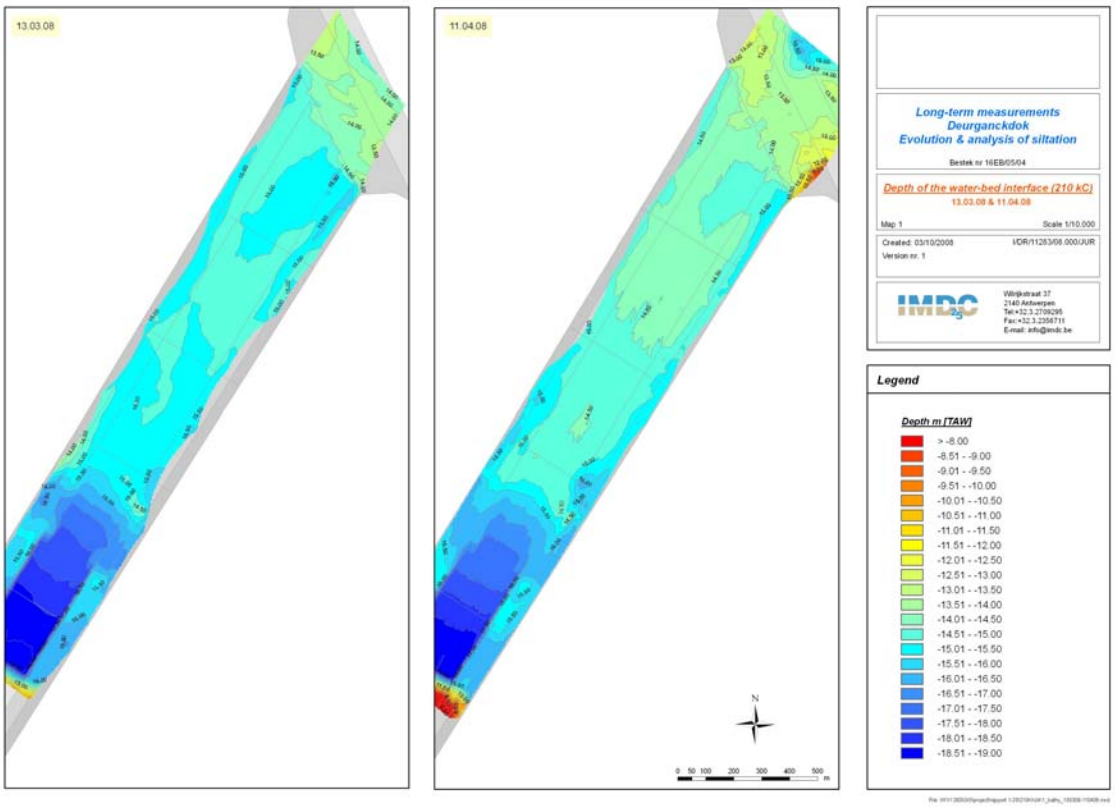


Figure 4-3: Example of a map showing depth of water-bed interface (210 kC) for 13/03/08 and 11/04/08

4.3. Evolution of water-bed interface (210 kC)

GIS grid maps show the difference charts for every depth sounding in relation to the reference situation (t_{0e}) and to the previous depth sounding (right). An example is shown in Figure 4-4.

The difference in depth between subsequent depth soundings for 210 kC measurements is also shown for all predefined sections. Graphs show a colour plot with Time in the X-axis, Distance to origin of section in the Y-axis and the depth of the top layer [m TAW] as a colour plot.

The origin for de the D sections is the northern quay wall. The origin of the L sections is the intersection between the L section with the Scheldt edge of zone 1. An example for sections is shown in Figure 4-5. The description of the sections is given in § 4.1.

Maps and graphs are shown in APPENDIX B.

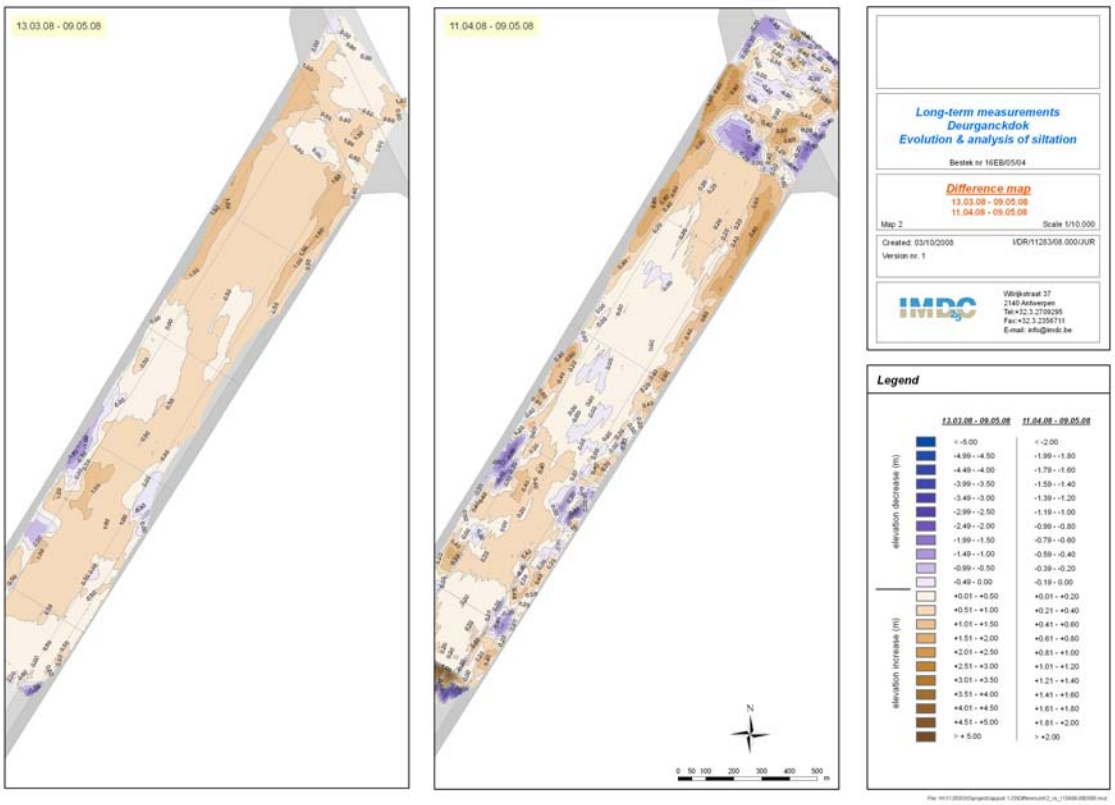


Figure 4-4: Difference charts of the depth sounding on 9/05/08: in reference to t_{0e} (left), and to the previous measurement (right) on 11/04/08

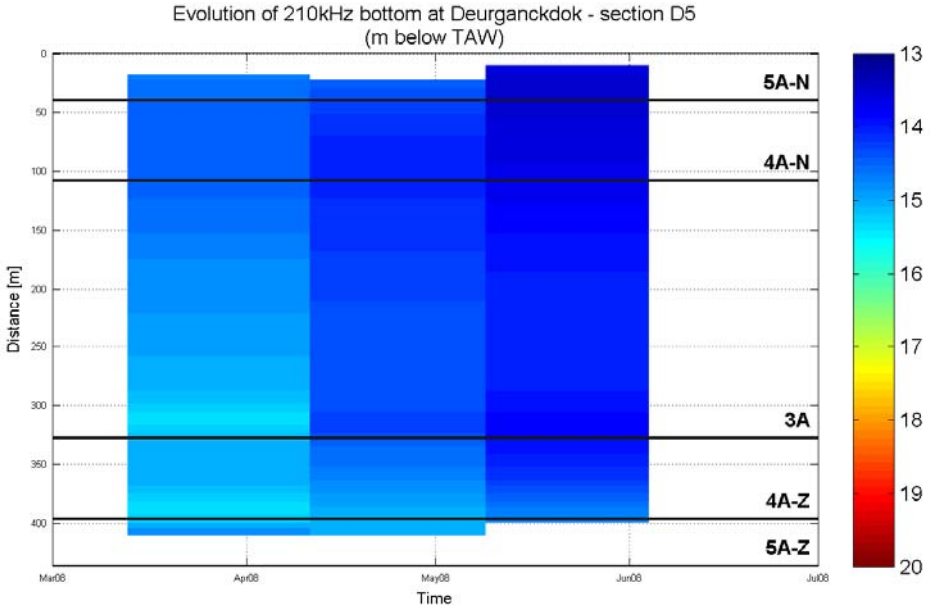


Figure 4-5: Graph of Evolution of the water-bed interface (210 kC) for section D5

4.4. Volumetric siltation rates [cm/day] in different zones and sections

A table with monthly average siltation rates for all (sub)zones is also given in APPENDIX C.

Graphs in APPENDIX C show two parameters:

- Average siltation rates [cm/day]: The average siltation rate is the difference in the depth of the water-bed interface and is calculated only for those zones and subzones that have at least a 50% surface area overlap between two subsequent depth soundings. This is done for all successive depth soundings. It is shown in the plots as a bar and is positive for sedimentation and negative for erosion or removal.
- Cumulative bed level change [m]: an initial situation (t_0) is used as baseline. Starting from this reference level the evolution of the average bed level elevation is shown for the particular (sub)zone.

Dredging events from the BIS system are marked on each of these graphs. This is computed for all zones, subzones, sections and Deurganckdok as a whole. As an example we show siltation rate and cumulative bed level change for zone 3a in Figure 4-6.

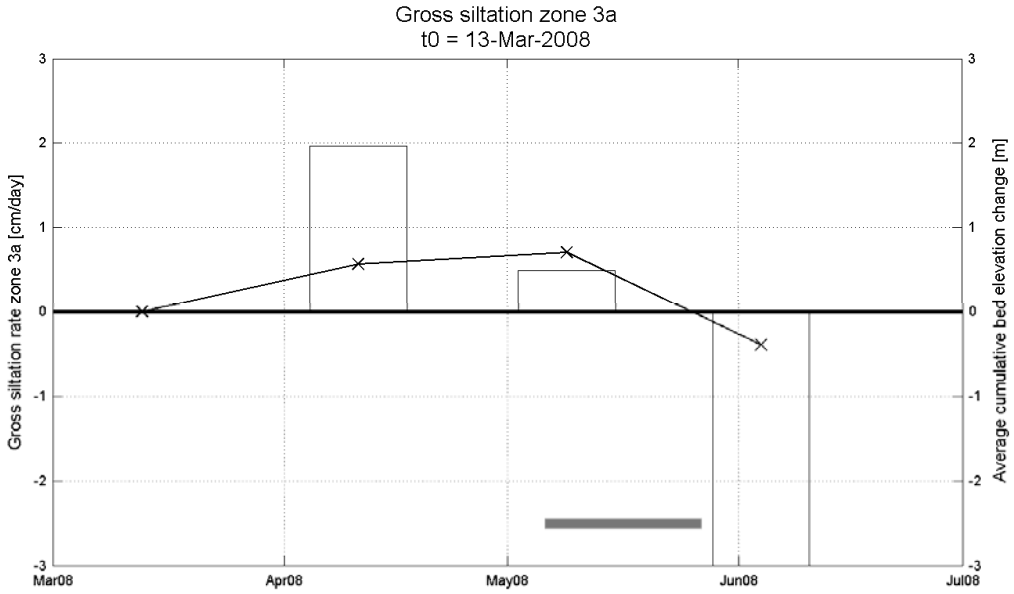


Figure 4-6: Volumetric siltation rate for zone 3a

4.5. Depth of water-bed interface (1.03 kg/dm³) and equal density layers

This analysis is based on density profile measurements from the Navitracker. Maps show the depth of water-bed interface and equal density layers (1.1, 1.2, 1.3 kg/dm³). The elevation of the water-bed interface is here defined as the depth at which the equipment encounters a density of 1.03 kg/dm³. This threshold is chosen since the maximum weight of salt and suspended sediment in the water column is estimated at 30 g/l, corresponding with a bulk density of about 1.03 kg/dm³. When the density passes this value, the equipment is assumed to reach the water-bed interface. The depth of the layers of constant density can be found in APPENDIX D, whereas APPENDIX E gives the density profiles for the different sections in Deurganckdok. An example for equal density

layers in section D4 is given in Figure 4-7. An example of a map is given in Figure 4-8. The description of the sections is given in § 4.1.

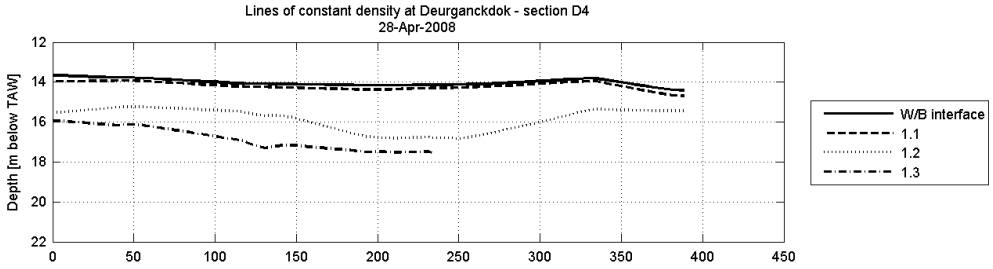


Figure 4-7: Depth of water-bed interface and equal density layers in section D4 on 28 April 2008

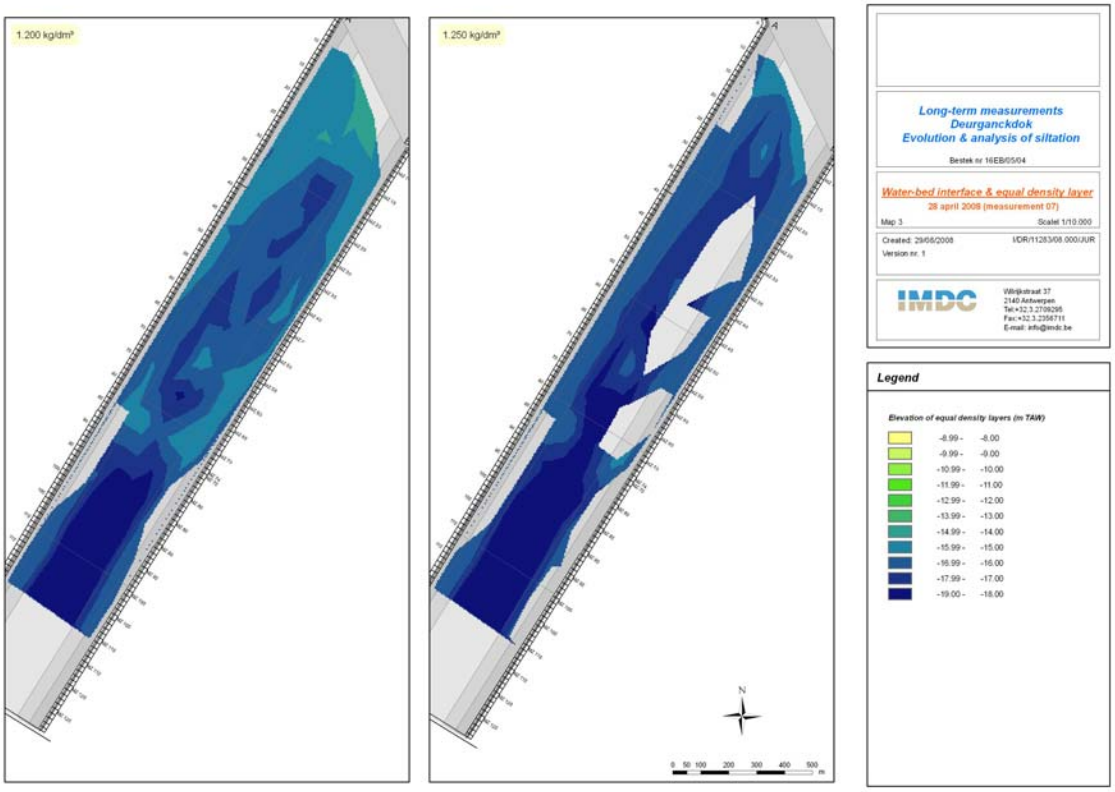


Figure 4-8: Map of the depth of the water-bed interface and equal density layers for 28/04/08

4.6. Evolution of water-bed interface and equal density layers elevation

The evolution of water-bed interface and equal density layers (1.1, 1.2 en 1.3 kg/dm³) are shown for all sections in APPENDIX F. The description of the sections is given in § 4.1. Note that the last measurement of the previous measurement campaign, i.e. 4 December 2007, is added to the present data series in order to have a good view on the density evolution. This makes 3 density measurements in total being used for this comparison. Sections of four different planes of constant

density are determined. These planes are determined by mapping the depths at which the specified densities have been encountered. For every measurement campaign the elevation of these planes across the sections has been plotted. An example is shown in Figure 4-9

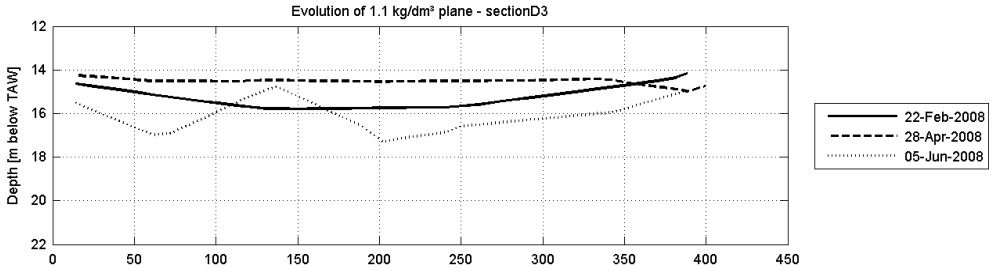


Figure 4-9: Graph of the evolution of 1.1 kg/dm³ plane in section D3

4.7. Measured mass maps

The measured mass in [TDS/m²] is calculated and visualized in maps for every measurement in reference to the empty dock at design depth (reference situation t_{0d}) (see §3.2). Every map is based on a density measurement.

These maps are shown in APPENDIX G.

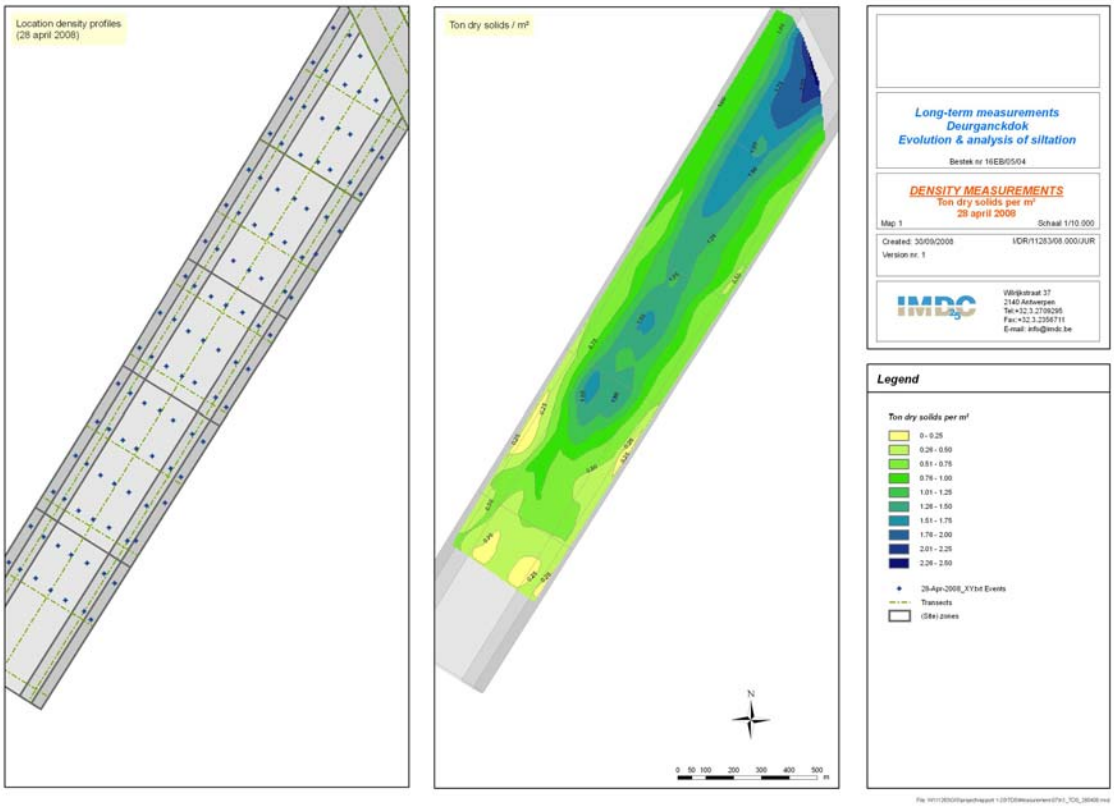


Figure 4-10: Map showing the location of the density profiles (left) and the calculation of TDS (right) on 28/04/08

4.8. Average net mass evolution

The average net mass growth [TDS/m²] in all zones and subzones is based on density profile measurements (measured sediment mass). The actual sediment mass present in the dock and measured by density profiling does not take the removed dredged material into account. The mass removed by dredging can be computed from BIS data (dredged material mass). Only zones spatially covered for 50% or more by density measurements are considered for sediment mass calculations. Unmeasured parts of these zones retrieve a value for the calculations (in order to close the mass balance of the zone), being the average mass per square meter based on the actual density measurements of the considered zone.

By adding measured mass to dredged material mass, the total accumulated mass and hence the growth can be shown (see Figure 4-11). In case this *total mass* can be computed for the complete dock (or a zone) for two subsequent measurements, an estimation of the net sediment flux into the dock (or zone) during the intermediate period is given by the difference of both total mass values. The net sediment flux into an area can also be defined as the net mass growth (kg/m² or Ton Dry Solids/m²). Division of the net mass growth of a zone by the number of days in between measurements leads to the averaged net mass growth rate. Note that the last measurement of the previous measurement campaign, i.e. 22 February 2008, is added to the present data series in order to have a good view on the net mass evolution.

Averaged net mass growth rate [kg/m²/day] is computed for each zone and subzone and is shown in APPENDIX H. An example is shown for zone 3B in Figure 4-12.

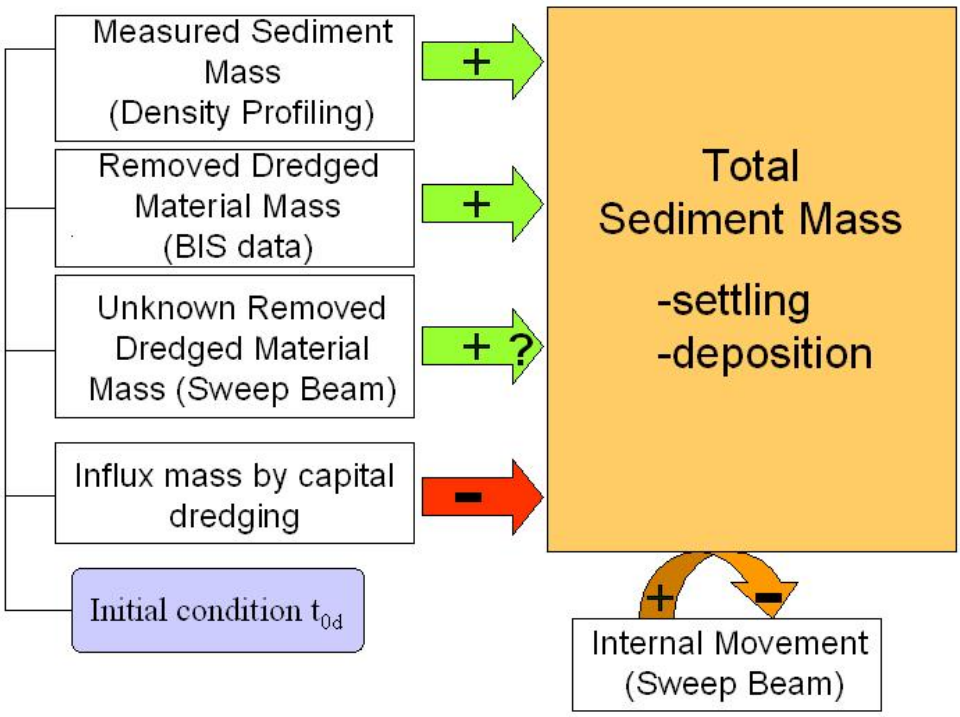


Figure 4-11: Flow chart with different elements contributing to total sediment mass for (sub)zones and total area

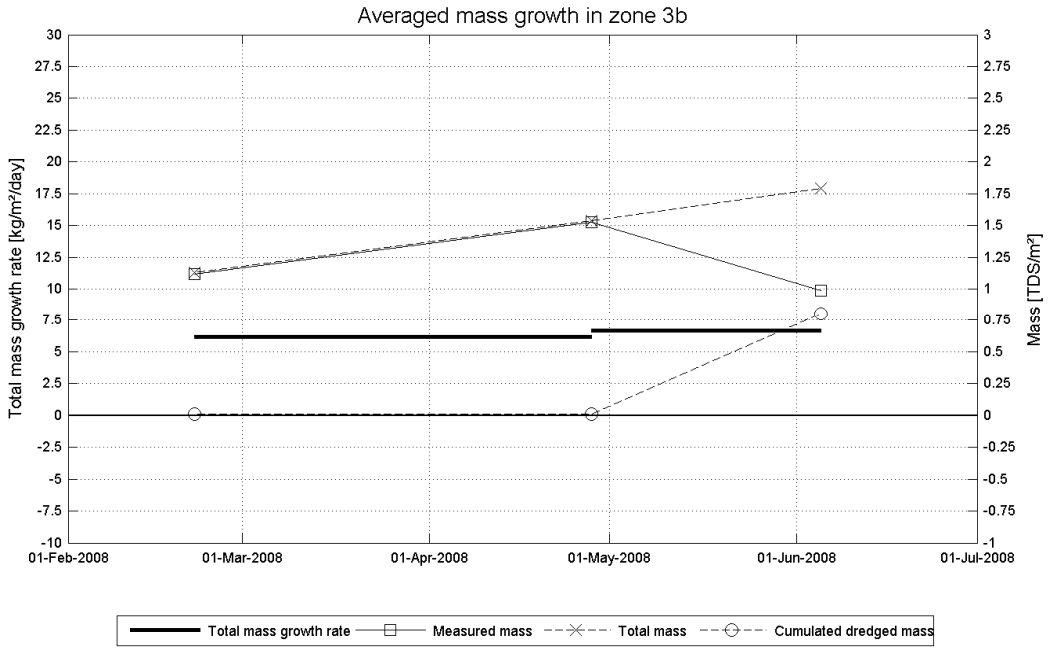


Figure 4-12: Example of averaged mass growth and mass evolution for subzone 3B

Clearly, the sediment mass balance is incomplete because sediment fluxes cannot be derived from the sweep beam data (of which no mass or volume information is available). Internal movements of sediment by the sweep beam (berthing zones to central trench) and removal of sediments from the sill into the Lower Sea Scheldt definitely influence the mass balance for (sub)zones and the total dock.

A table in APPENDIX H gives an overview for all zones and subzones for the following parameters, and this only if data is available for at least 50 % of this (sub)zone:

- Measured Sediment mass [TDS/m²]
- Dredged Material mass (absolute) [TDS]
- Total Sediment mass [TDS/m²]
- Growth rate [kg/m²/day]]
- Total area [ha]
- Covered area [ha]: area covered by density profiles
- Percent of zone covered [%]

5. PRELIMINARY ANALYSIS OF THE DATA

5.1. Volumetric analysis

Depth sounding data is processed to show the evolution of the average sediment volume per unit of surface, i.e. the average evolution of bed level as detected by a 210 kHz sounder. If more than 50% of the area of a (sub)zone is covered, an average siltation rate is calculated. For the period of April - June 2008, depth soundings were performed on 11 April, 9 May and 4 June 2008. During these measurements, an adequate coverage was obtained during depth soundings for subzones A-D for zones 2, 3 and 4.

The bathymetric measurements in APPENDIX A and the corresponding bathymetric difference maps in APPENDIX B show that the bed interface moves to decreasing depths between the reference date of 13 March 2008 and the third depth sounding on 9 May 2008. A dredging campaign of three weeks subsequently lowered the bed level in general.

From APPENDIX C, it is clear that for the three first months (March – May) a bed level increase was observed. In general, the bed level increase levelled off a bit in time. A decrease was seen from May to June and was obviously due to dredging. This resulted in a negative (volumetric) siltation rate between 9 May and 4 June 2008. The positive siltation rates valued between 0.25 and 1.96 cm/day in the central trench (except for zone E). The rates for zone 3 were in the same range as the values recorded in the annual sediment balance of 2007-2008 (IMDC, 2007n) for the periods of 27/04/2007 – 27/07/2007 and 4/12/2007 – 25/1/2008. Instead, zone 4 showed similar results. It could also be concluded that the siltation rates decreased when moving further inside the dock (starting from the entrance); an exception to this behaviour however is zone 3D. This longitudinal trend is also in accordance to previous measurements (see e.g. IMDC, 2007n). When investigating the dock-transverse trend of the siltation rates, it could be seen that no significant difference occurred between the northern and southern quays.

5.2. Densimetric analysis

Hopper maintenance dredging occurred during three consecutive weeks, i.e. 12 May – 1 June 2008 (see Table 5-1). BIS data revealed that more than 370×10^3 TDS was dredged in this period. Amounts of dredged mass decreased over the three weeks of activity. The majority of dredged mass originated from zones 3A-C (more than 74%). The amount decreased when moving further inside the dock, which is in accordance to the natural siltation rates, i.e. siltation rates lower too when moving away from the Scheldt river inside the dock.

Table 5-1: Dredged sediment mass (TDS)

	12-May-08	19-May-08	26-May-08	
zone	**18-May-08**	**28-May-08**	**01-Jun-08**	**% Total**
1				
2	523	989	746	0.6
3a	59931	36320	21332	31.5
3b	34338	36401	25286	25.8
3c	17708	25536	20847	17.2
3d	946	5952	8877	4.2
3e			541	0.1
4Na	8337	4706	2455	4.2
4Nb	5739	5745	5503	4.6
4Nc	2594	2216	2962	2.1
4Nd	39	157	1242	0.4
4Ne			64	0.0
4Za	7668	6137	1054	4.0
4Zb	5496	8591	887	4.0
4Zc	949	3290	239	1.2
4Zd	302	230	15	0.1
4Ze			2	0.0
5Na	3			0.0
Total	144573	136270	92053	372895
% Total	38.8	36.5	24.7	

From the measured vertical density profiles, the temporal evolution of planes of constant density can be investigated. The results can be found in APPENDIX F. The lowering of these equal density planes by dredging is clear (cf. 5 June 2008). Note also that a bump of sediment occurred at one-third of the dock's back-end in the measurements of 22 February 2008 and, subsequently, being dredged away in April 2008.

Vertical density profiles have also been numerically integrated to calculate the mass of dry solids above a reference plane for each zone (i.e. the design depth of Deurganckdok t_{0d} (see §2.1)). This data availability also enables the use of the densimetric dredging data, cf. BIS data, in the mass balance calculations. Adding up the measured and dredged masses leads to the total sediment mass as shown in APPENDIX H. Results show a mass growth rate in the central trench (zones 3A-D) in the range of 1.8 to 13.5 kg/m²/day for the period February – June 2008. These numbers are similar to those of September 2007 – February 2008 with values between 2 and 15 kg/m²/day. Note also that the period of 28 April – 5 June showed larger growth rates than the period of 22 February – 28 April 2008. This difference seemed to be linked to dredging activities because only in the former period dredging occurred. A similar observation was done in January – February 2008, where elevated growth rates occurred when including dredged masses in the calculations. Zones 4N-A, 4N-B and 4N-C showed growth rates in the range of 2 – 6 kg/m²/day, being comparable to those for the periods September–November 2007.

An overview of the total mass settled over time, for all zones that have been covered for 100%, is shown in Table 5-2 and Table 5-3. From these figures, it is concluded that between the end of April

and the beginning of June about 152x10³ tons of dry solids have settled in zones 3 and 4, subzones A, B and C. This is in a similar range as for the period of mid-January to mid-February (148x10³ TDS), but is much larger than the observed 76x10³ and 66x10³ tons of dry solids being obtained for the periods September-October and October-November 2007 respectively.

Subdividing per subzone (Table 5-3), it is concluded that the settled mass in subzones A (nearest to river) was generally larger than the settled mass in subzones B and C. This confirms the hypothesis of a gradual decrease in siltation with distance from the Scheldt river.

Table 5-2: Total sediment mass (measured + dredged, in 10³ TDS) in some zones

zone	28-Apr-08	05-Jun-08
3a	169	219
3b	145	193
3c	142	171
3d	161	170
4Na	36	41
4Nb	25	33
4Nc	20	23
4Nd	24	22
4Za	26	30
4Zb	25	31
4Zc	21	20
4Zd	21	18

Table 5-3: Mass settled per subzone in zones 3 and 4 (measured + dredged, in 10³ TDS)

	22-Feb-2008 / 28-Apr-2008	28-Apr-2008 / 05-Jun-2008
subzone A	34	59
subzone B	31	62
subzone C	27	31
subzone D	18	5

6. REFERENCES

AMT(2003). Intern rapport, Getij-informatie Scheldebekken 1991-2000.

AWZ (2000): Baggerwerken 2000, Westerschelde en Zeeschelde

IMDC (2006a) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.6 Sediment balance Bathymetry: 2005 – 3/2006 (I/RA/11283/06.118/MSA)

IMDC (2006b) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.1 Through tide measurement SiltProfiler 21/03/2006 Laure Marie (I/RA/11283/06.087/WGO).

IMDC (2006c) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.3 Through tide measurement Sediview spring tide 22/03/2006 Veremans (I/RA/11283/06.110/BDC)

IMDC (2006d) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.4 Through tide measurement Sediview spring tide 27/09/2006 Parel 2 (I/RA/11283/06.119/MSA).

IMDC (2006e) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.6 Salt-Silt distribution & Frame Measurements Deurganckdok 13/3/2006 – 31/05/2006 (I/RA/11283/06.121/MSA).

IMDC (2006f). Uitbreiding studie densiteitsstromingen in de Beneden Zeeschelde in het kader van LTV Meetcampagne naar hooggeconcentreerde slibsuspensies Deelrapport 6.1 Winter Calibration (I/RA/11291/06.092/MSA), in opdracht van AWZ.

IMDC (2007a) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.1 Sediment Balance: Three monthly report 1/4/2006 – 30/06/2006 (I/RA/11283/06.113/MSA)

IMDC (2007b) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.2 Sediment Balance: Three monthly report 1/7/2006 – 30/09/2006 (I/RA/11283/06.114/MSA)

IMDC (2007c) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.3 Sediment Balance: Three monthly report 1/10/2006 – 31/12/2006 (I/RA/11283/06.115/MSA)

IMDC (2007d) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.4 Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.116/MSA)

IMDC (2007e) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.5 Annual Sediment Balance (I/RA/11283/06.117/MSA)

IMDC (2007f) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.2 Through tide measurement SiltProfiler 26/09/2006 Stream (I/RA/11283/06.068/MSA)

IMDC (2007g) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.5 Through tide measurement Sediview neap tide (to be scheduled) (I/RA/11283/06.120/MSA)

IMDC (2007h) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.7 Salt-Silt distribution & Frame Measurements Deurganckdok 15/07/2006 – 31/10/2006 (I/RA/11283/06.122/MSA)

IMDC (2007i) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.8 Salt-Silt distribution & Frame Measurements Deurganckdok 15/01/2007 – 15/03/2007 (I/RA/11283/06.123/MSA)

IMDC (2007j) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 3.1 Boundary conditions: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.127/MSA)

IMDC (2007k) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 3.2 Boundary conditions: Annual report (I/RA/11283/06.128/MSA)

IMDC (2007l) Uitbreiding studie densiteitsstromingen in de Beneden Zeeschelde in het kader van LTV Meetcampagne naar hooggeconcentreerde slibsuspensies Deelrapport 6.2 Summer Calibration and Final Report (I/RA/11291/06.093/MSA)

IMDC (2007m). Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.11 Sediment Balance: Two monthly report 1/7/2007 – 31/08/2007 (I/RA/11283/07.082/MSA).

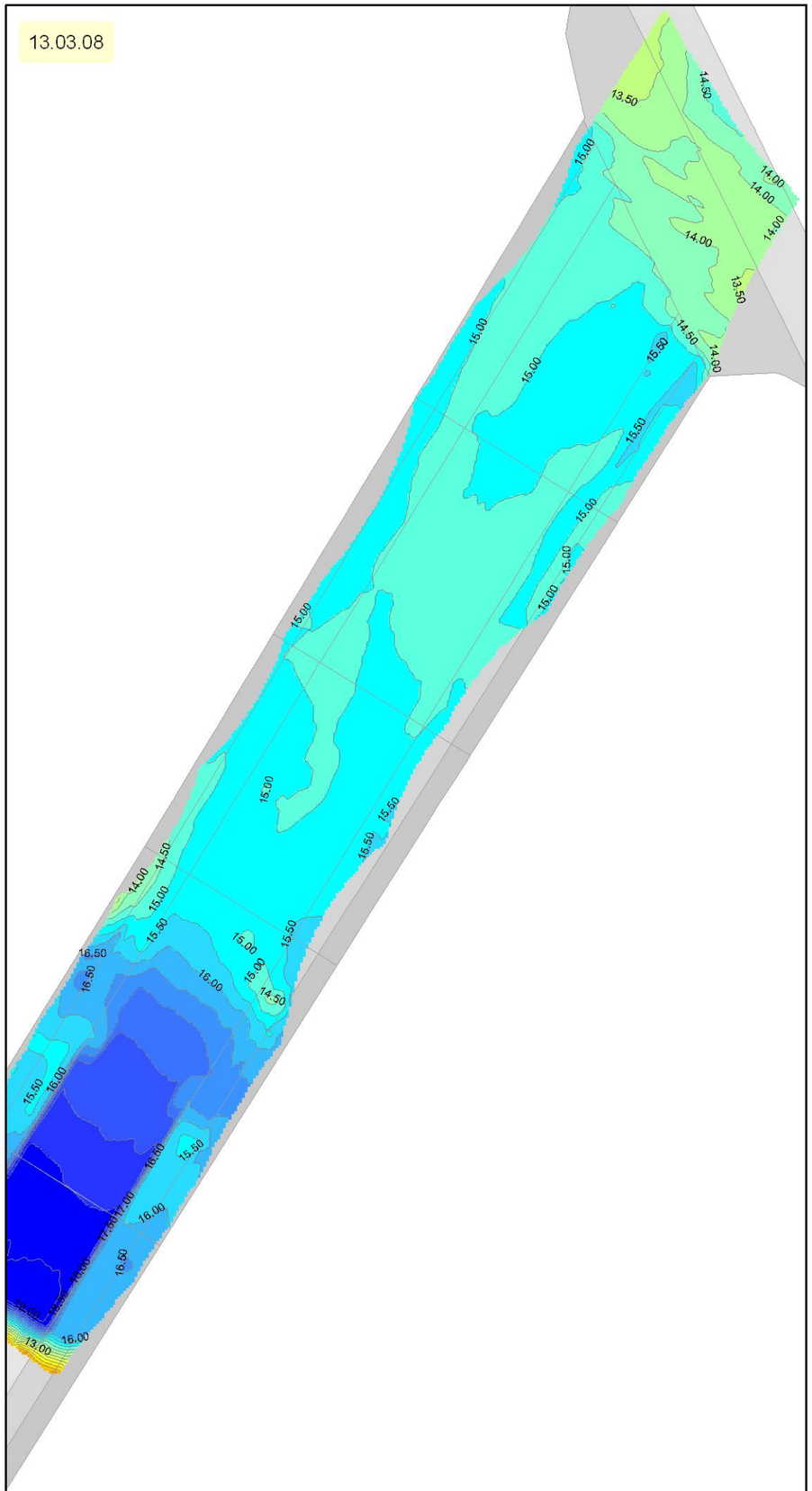
IMDC (2007n). Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.14 Annual sediment balance (I/RA/11283/07.085/MSA).

IMDC (2007o). Calibration stationary & mobile equipment winter (I/RA/11283/07.096/MSA).

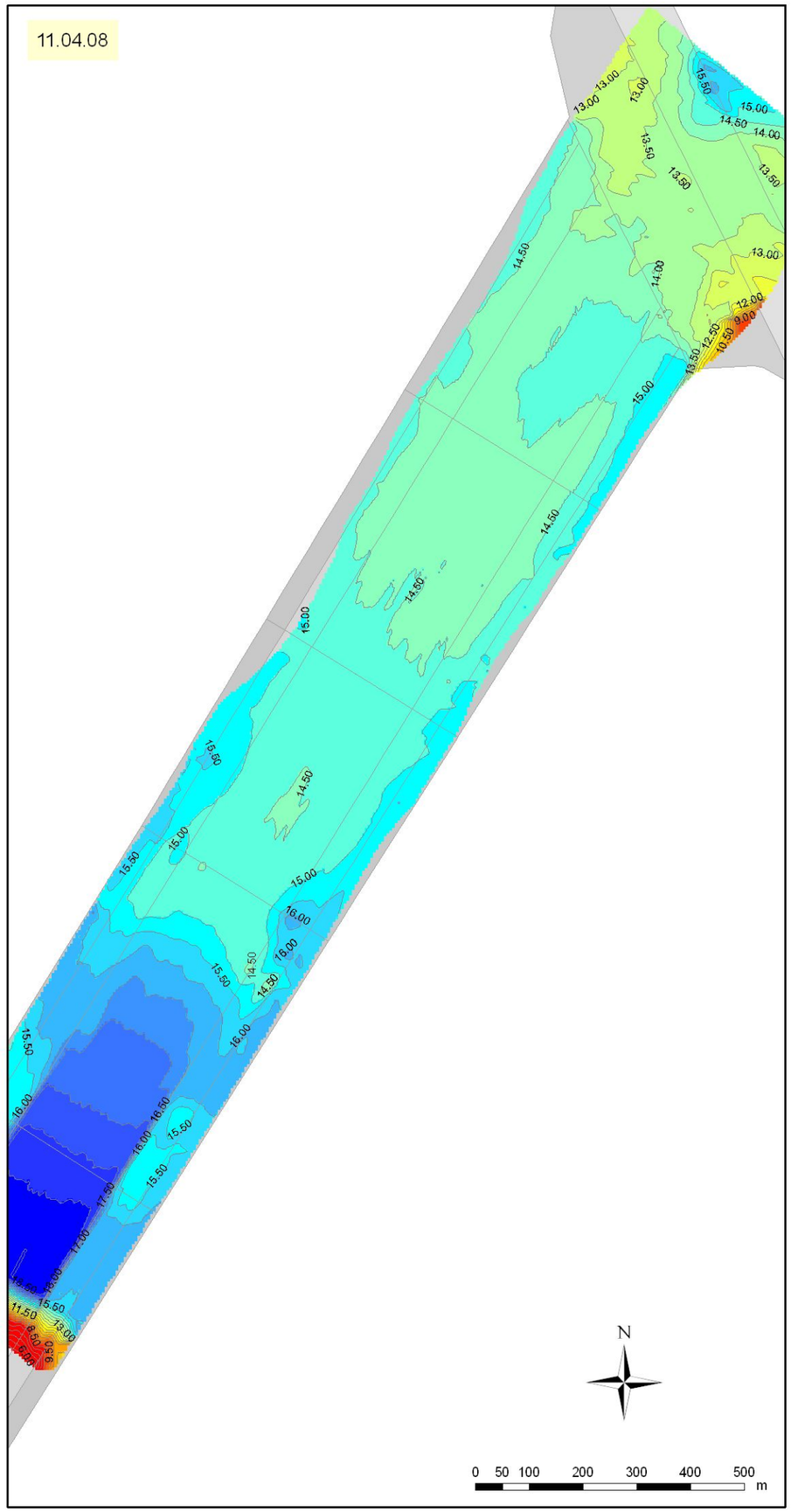
IMDC (2008). Feasibility study of echo sounding to determine fluid mud density profiles (I/NO/11283/08.001/BOB).

APPENDIX A. DEPTH OF THE WATER-BED INTERFACE (210 KC)

13.03.08



11.04.08



Long-term measurements
Deurganckdok
Evolution & analysis of siltation

Bestek nr 16EB/05/04

Depth of the water-bed interface (210 kC)

13.03.08 & 11.04.08

Map 1 Scale 1/10.000

Created: 03/10/2008 I/DR/11283/08.000/JUR

Version nr. 1

IMDC

Wilrijkstraat 37
2140 Antwerpen
Tel:+32.3.2709295
Fax:+32.3.2356711
E-mail: info@imdc.be

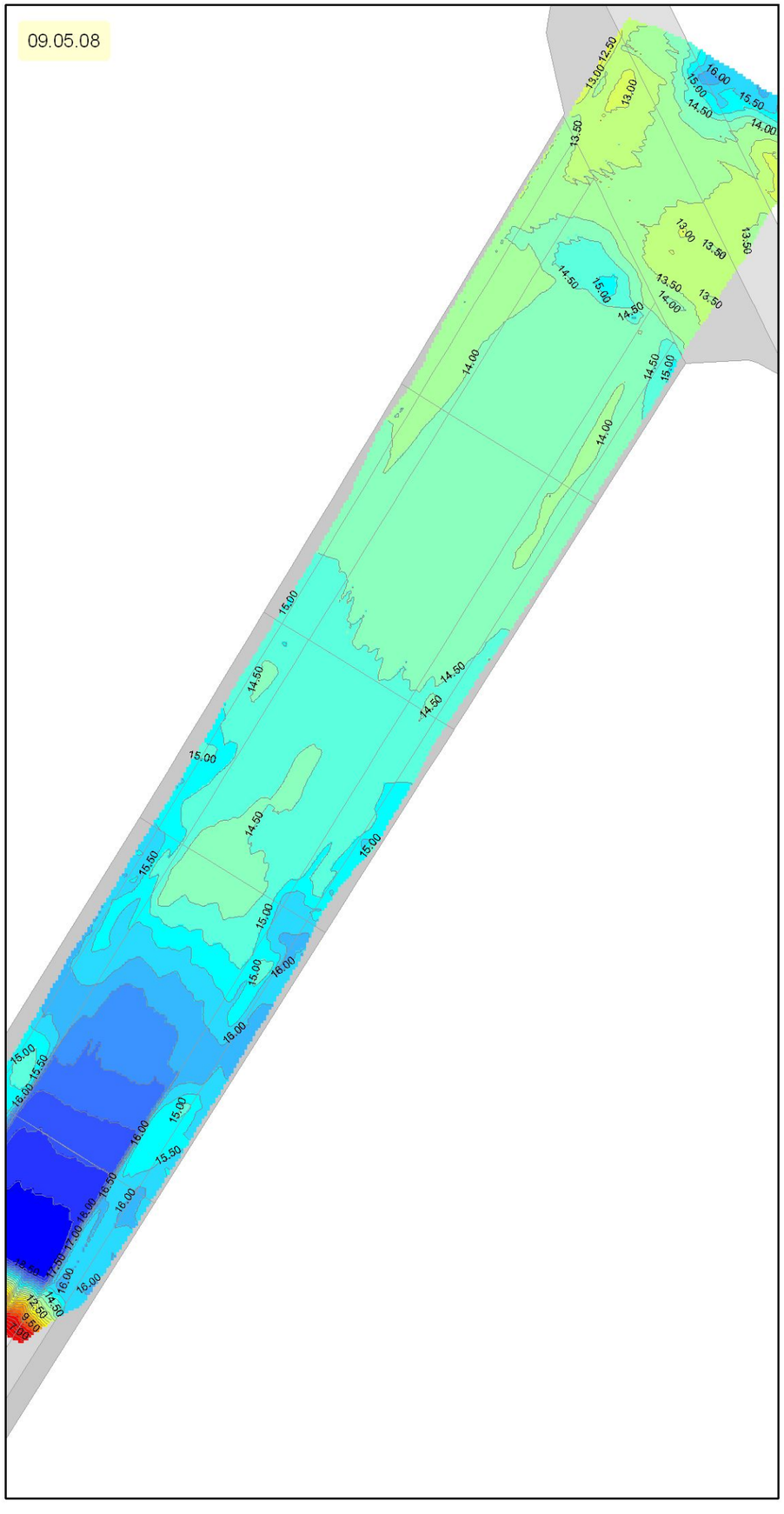
Legend

Depth m [TAW]

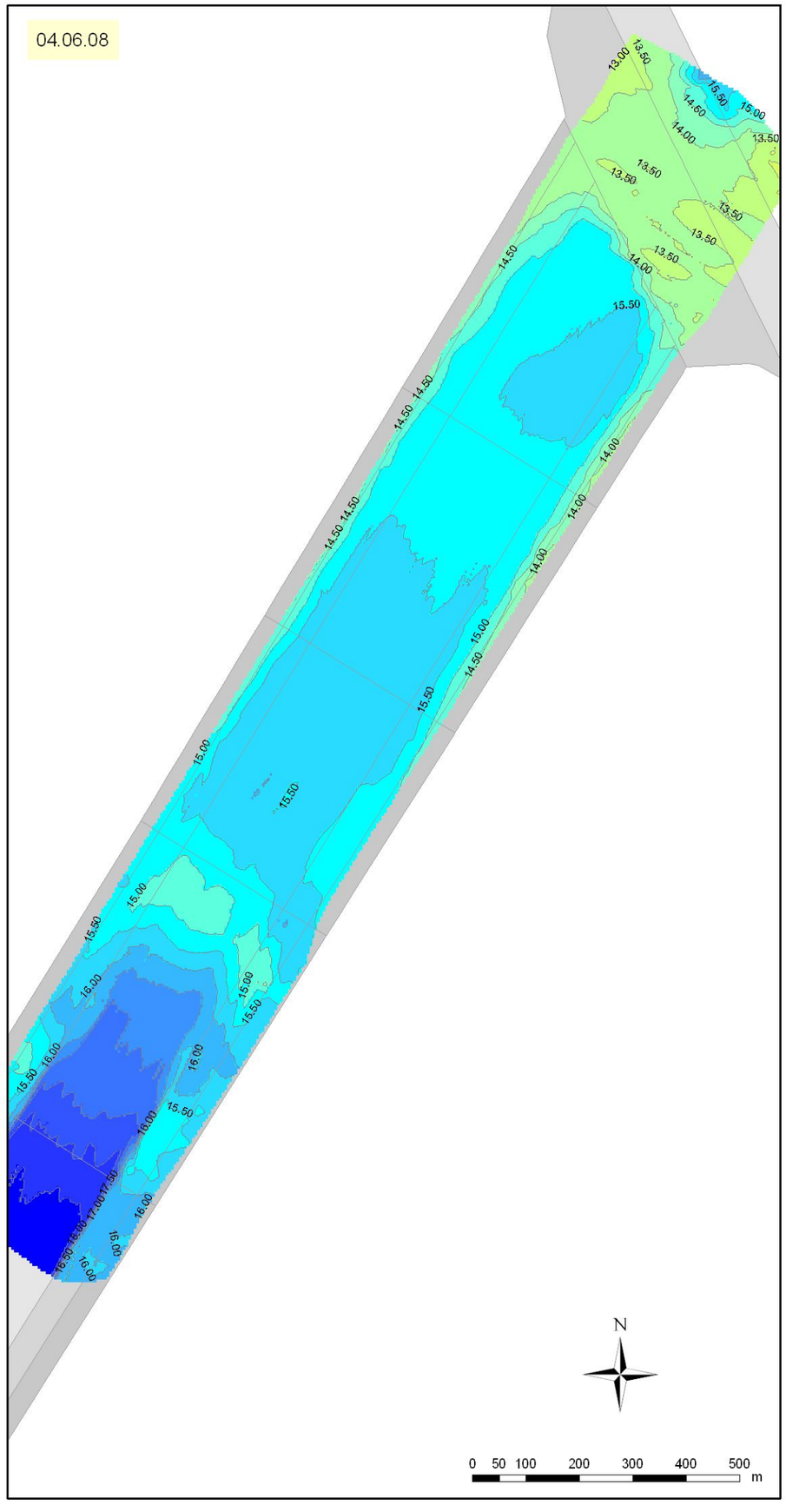
- > -8.00
- -8.51 - -9.00
- -9.01 - -9.50
- -9.51 - -10.00
- -10.01 - -10.50
- -10.51 - -11.00
- -11.01 - -11.50
- -11.51 - -12.00
- -12.01 - -12.50
- -12.51 - -13.00
- -13.01 - -13.50
- -13.51 - -14.00
- -14.01 - -14.50
- -14.51 - -15.00
- -15.01 - -15.50
- -15.51 - -16.00
- -16.01 - -16.50
- -16.51 - -17.00
- -17.01 - -17.50
- -17.51 - -18.00
- -18.01 - -18.50
- -18.51 - -19.00

File: W:\11283\GIS\project\rapport 1-20\210Khz\K1_bathy_130308-110408.mxd

09.05.08



04.06.08



Long-term measurements Deurganckdok Evolution & analysis of siltation

Bestek nr 16EB/05/04

Depth of the water-bed interface (210 kC)

09.05.08 & 04.06.08

Map 2 Scale 1/10.000

Created: 03/10/2008 I/DR/11283/08.000/JUR

Version nr. 1

Wilrijkstraat 37
2140 Antwerpen
Tel:+32.3.2709295
Fax:+32.3.2356711
E-mail: info@imdc.be

Legend

Depth m [TAW]

- > -8.00
- -8.51 - -9.00
- -9.01 - -9.50
- -9.51 - -10.00
- -10.01 - -10.50
- -10.51 - -11.00
- -11.01 - -11.50
- -11.51 - -12.00
- -12.01 - -12.50
- -12.51 - -13.00
- -13.01 - -13.50
- -13.51 - -14.00
- -14.01 - -14.50
- -14.51 - -15.00
- -15.01 - -15.50
- -15.51 - -16.00
- -16.01 - -16.50
- -16.51 - -17.00
- -17.01 - -17.50
- -17.51 - -18.00
- -18.01 - -18.50
- -18.51 - -19.00

File: W:\11283\GIS\project\rapport 1-20\210Khz\K2_bathy_090508-040608.mxd

APPENDIX B. EVOLUTION OF DEPTH OF WATER-BED INTERFACE (210 KC)

B.1 Difference maps

13.03.08 - 11.04.08

Long-term measurements Deurganckdok Evolution & analysis of siltation

Bestek nr 16EB/05/04

Difference map

13.03.08 - 11.04.08

Map 1 — Scale 1/10.000

Created: 03/10/2008 — I/DR/11283/08.000/JUR

Version nr. 1

Wilrijkstraat 37
2140 Antwerpen
Tel:+32.3.2709295
Fax:+32.3.2356711
E-mail: info@imdc.be

Legend

13.03.08 - 11.04.08

elevation decrease (m)

- < -5.00
- -4.99 - -4.50
- -4.49 - -4.00
- -3.99 - -3.50
- -3.49 - -3.00
- -2.99 - -2.50
- -2.49 - -2.00
- -1.99 - -1.50
- -1.49 - -1.00
- -0.99 - -0.50
- -0.49 - 0.00

elevation increase (m)

- +0.01 - +0.50
- +0.51 - +1.00
- +1.01 - +1.50
- +1.51 - +2.00
- +2.01 - +2.50
- +2.51 - +3.00
- +3.01 - +3.50
- +3.51 - +4.00
- +4.01 - +4.50
- +4.51 - +5.00
- > + 5.00

File: W:\11283\GIS\project\rapport 1-20\Difference\K1_vk_130308-110408.mxd

13.03.08 - 09.05.08

11.04.08 - 09.05.08

N

0 50 100 200 300 400 500 m

Long-term measurements Deurganckdok Evolution & analysis of siltation

Bestek nr 16EB/05/04

Difference map

13.03.08 - 09.05.08
11.04.08 - 09.05.08

Map 2 Scale 1/10.000

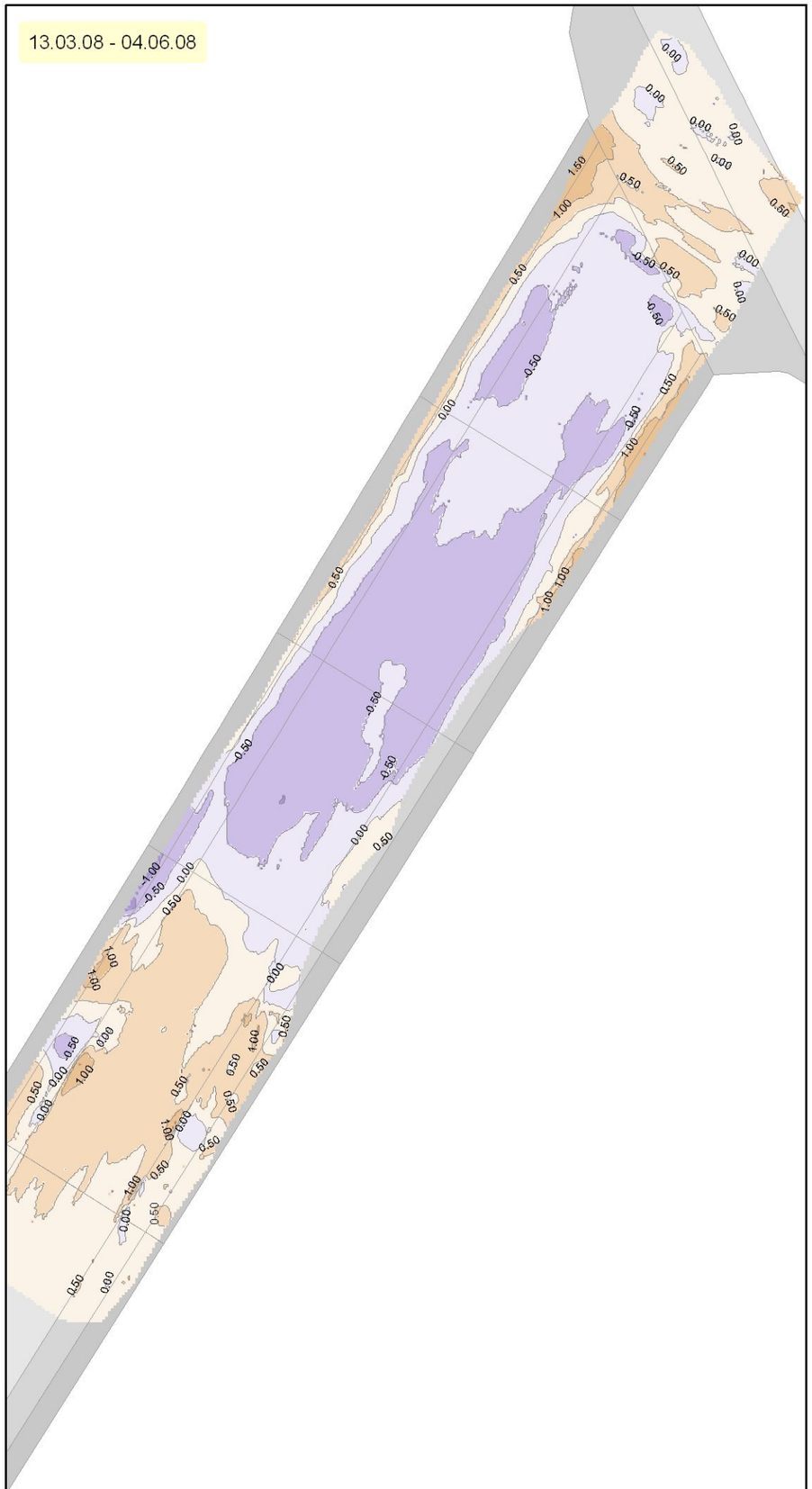
Created: 03/10/2008 I/DR/11283/08.000/JUR
Version nr. 1

IMDC
Wilrijkstraat 37
2140 Antwerpen
Tel:+32.3.2709295
Fax:+32.3.2356711
E-mail: info@imdc.be

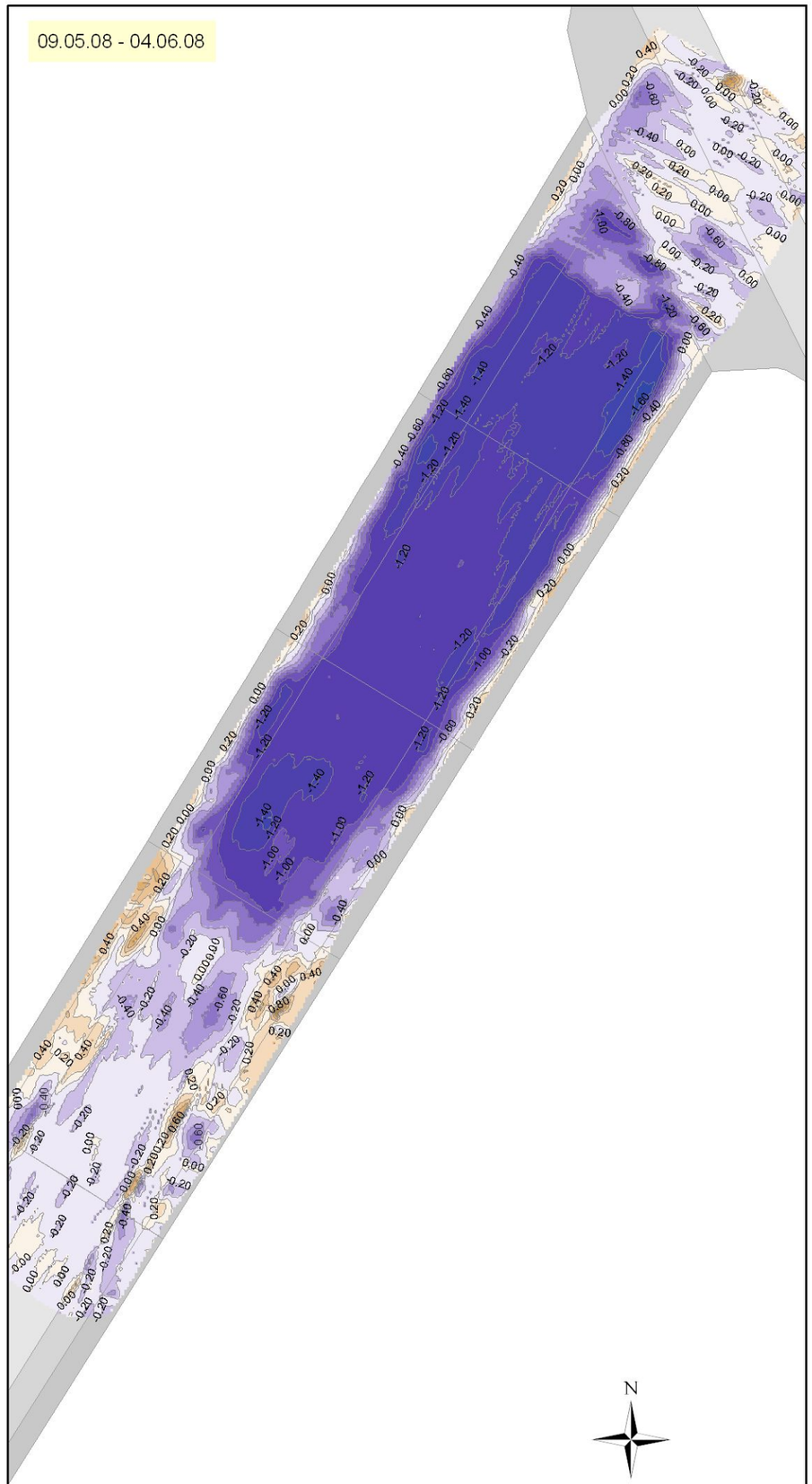
Legend

	13.03.08 - 09.05.08	11.04.08 - 09.05.08
elevation decrease (m)	< -5.00	< -2.00
	-4.99 - -4.50	-1.99 - -1.80
	-4.49 - -4.00	-1.79 - -1.60
	-3.99 - -3.50	-1.59 - -1.40
	-3.49 - -3.00	-1.39 - -1.20
	-2.99 - -2.50	-1.19 - -1.00
	-2.49 - -2.00	-0.99 - -0.80
	-1.99 - -1.50	-0.79 - -0.60
	-1.49 - -1.00	-0.59 - -0.40
	-0.99 - -0.50	-0.39 - -0.20
	-0.49 - 0.00	-0.19 - 0.00
elevation increase (m)	+0.01 - +0.50	+0.01 - +0.20
	+0.51 - +1.00	+0.21 - +0.40
	+1.01 - +1.50	+0.41 - +0.60
	+1.51 - +2.00	+0.61 - +0.80
	+2.01 - +2.50	+0.81 - +1.00
	+2.51 - +3.00	+1.01 - +1.20
	+3.01 - +3.50	+1.21 - +1.40
	+3.51 - +4.00	+1.41 - +1.60
	+4.01 - +4.50	+1.61 - +1.80
	+4.51 - +5.00	+1.81 - +2.00
	> + 5.00	> +2.00

13.03.08 - 04.06.08



09.05.08 - 04.06.08



Long-term measurements
Deurganckdok
Evolution & analysis of siltation

Bestek nr 16EB/05/04

Difference map
13.03.08 - 04.06.08
09.05.08 - 04.06.08

Map 3 Scale 1/10.000

Created: 03/10/2008 I/DR/11283/08.000/JUR
Version nr. 1

IMDC
Wilrijkstraat 37
2140 Antwerpen
Tel:+32.3.2709295
Fax:+32.3.2356711
E-mail: info@imdc.be

Legend

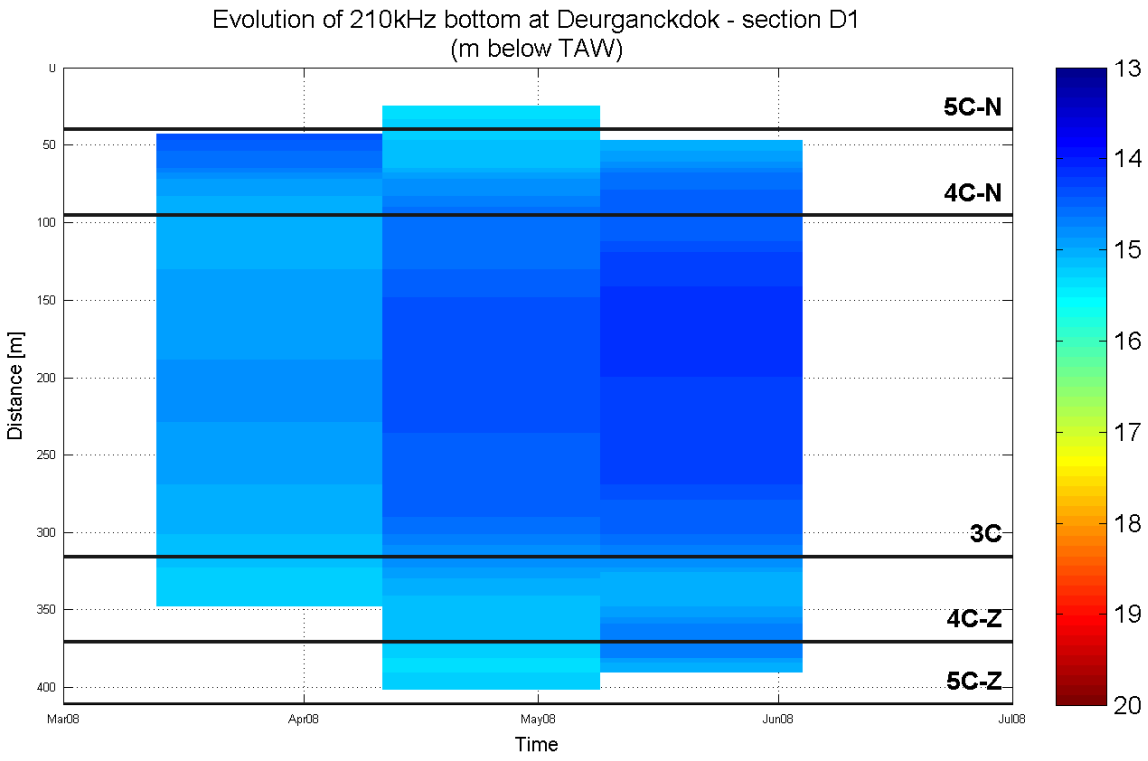
	13.03.08 - 04.06.08	09.05.08 - 04.06.08
elevation decrease (m)	< -5.00	< -2.00
	-4.99 - -4.50	-1.99 - -1.80
	-4.49 - -4.00	-1.79 - -1.60
	-3.99 - -3.50	-1.59 - -1.40
	-3.49 - -3.00	-1.39 - -1.20
	-2.99 - -2.50	-1.19 - -1.00
	-2.49 - -2.00	-0.99 - -0.80
	-1.99 - -1.50	-0.79 - -0.60
	-1.49 - -1.00	-0.59 - -0.40
	-0.99 - -0.50	-0.39 - -0.20
	-0.49 - 0.00	-0.19 - 0.00
elevation increase (m)	+0.01 - +0.50	+0.01 - +0.20
	+0.51 - +1.00	+0.21 - +0.40
	+1.01 - +1.50	+0.41 - +0.60
	+1.51 - +2.00	+0.61 - +0.80
	+2.01 - +2.50	+0.81 - +1.00
	+2.51 - +3.00	+1.01 - +1.20
	+3.01 - +3.50	+1.21 - +1.40
	+3.51 - +4.00	+1.41 - +1.60
	+4.01 - +4.50	+1.61 - +1.80
	+4.51 - +5.00	+1.81 - +2.00
	> + 5.00	> +2.00

File: W:\11283\GIS\project\rapport 1-20\Difference\K3_vk_090508-040608.mxd

B.2 Bed elevation evolution per section

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



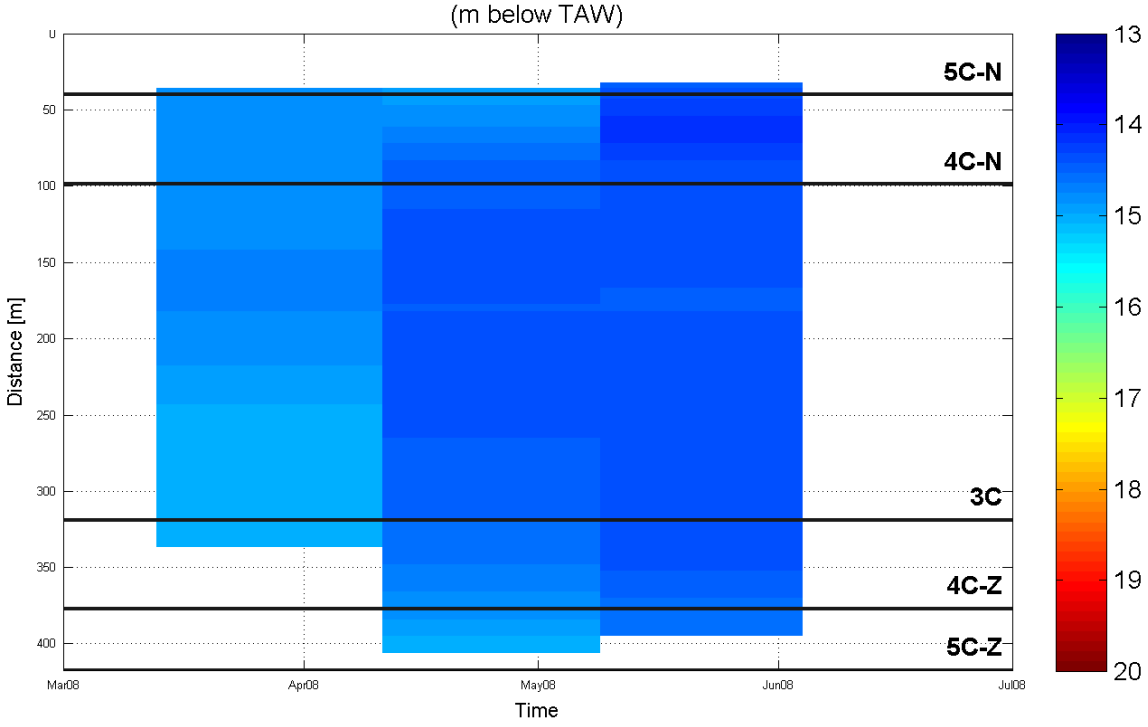
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



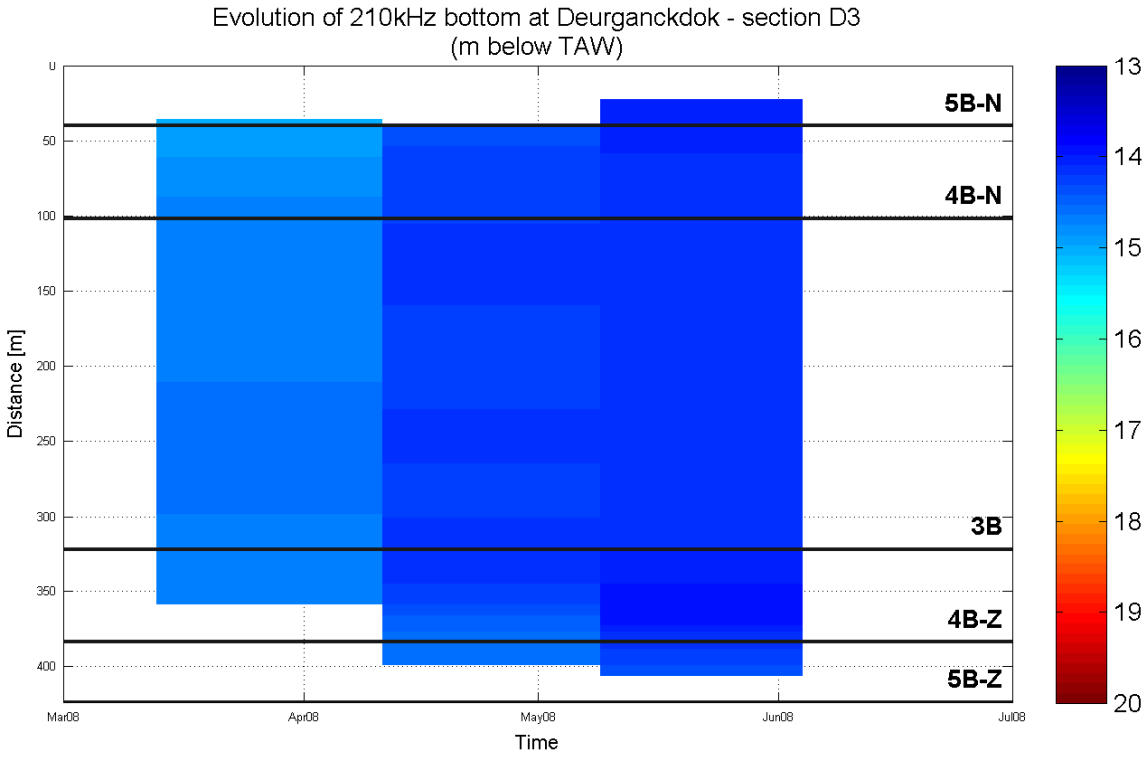
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



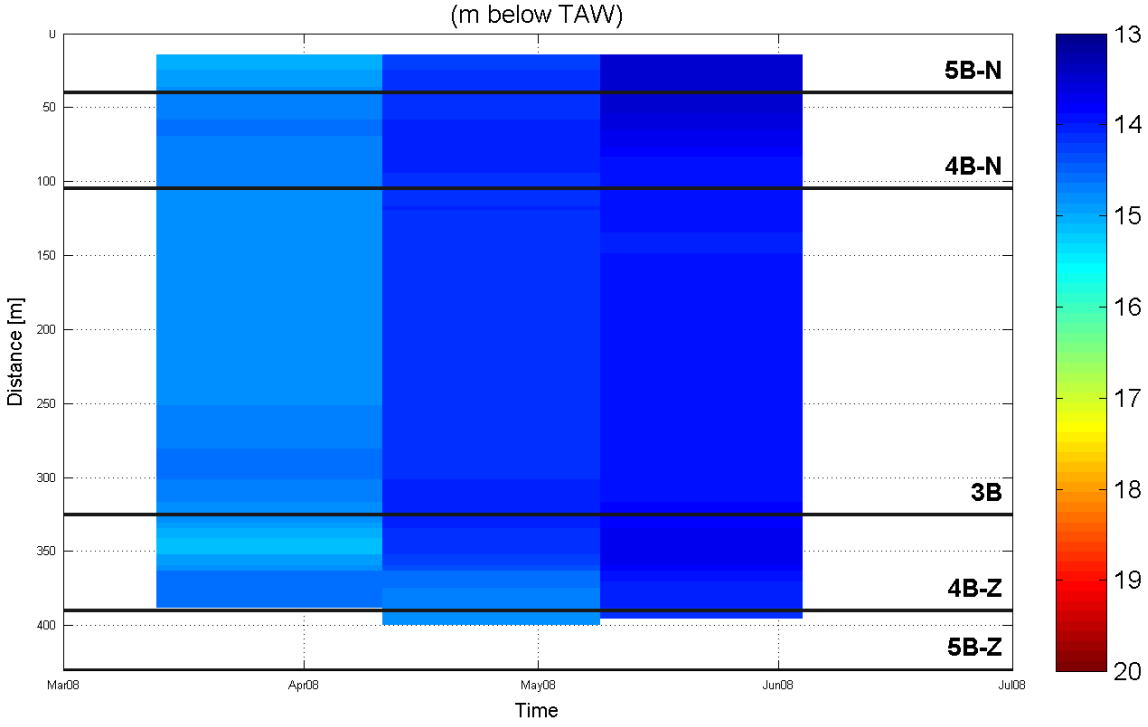
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



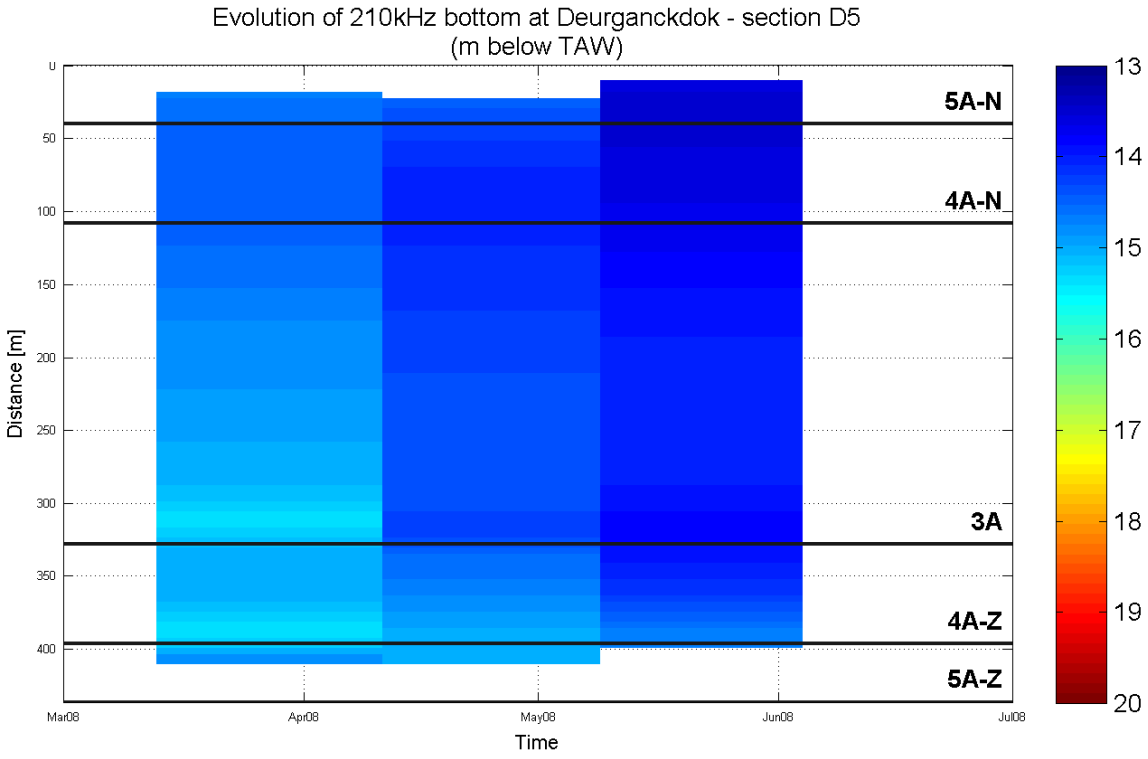
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



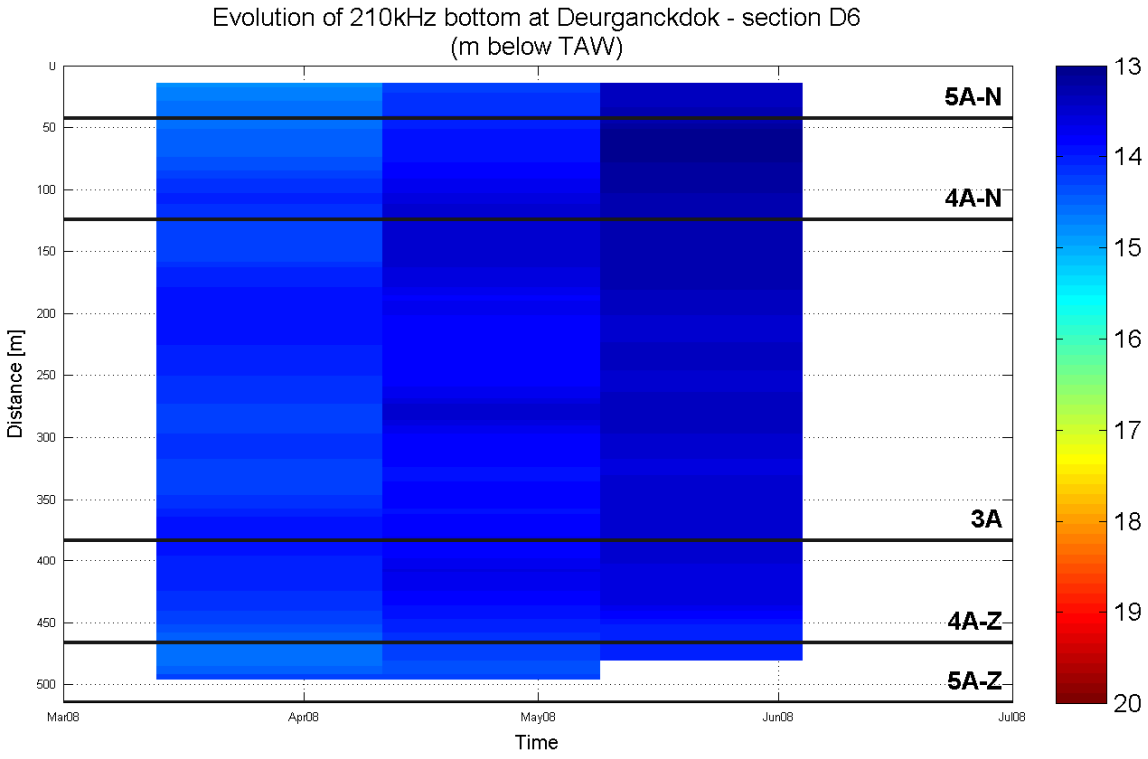
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



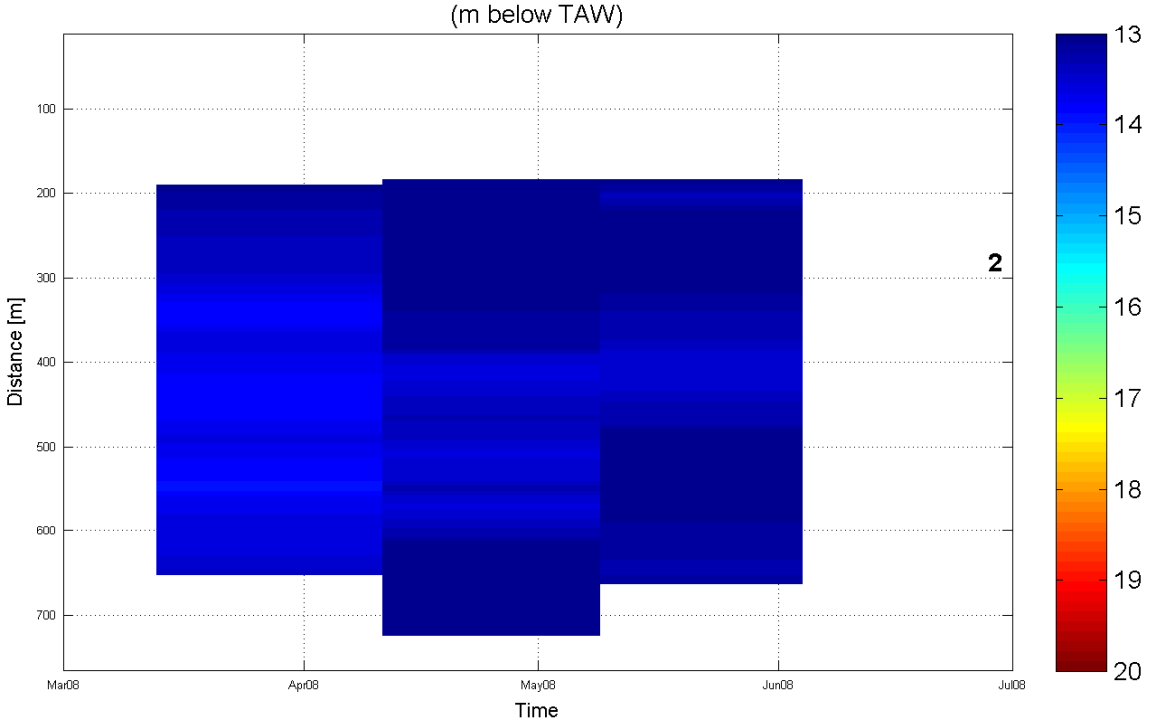
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



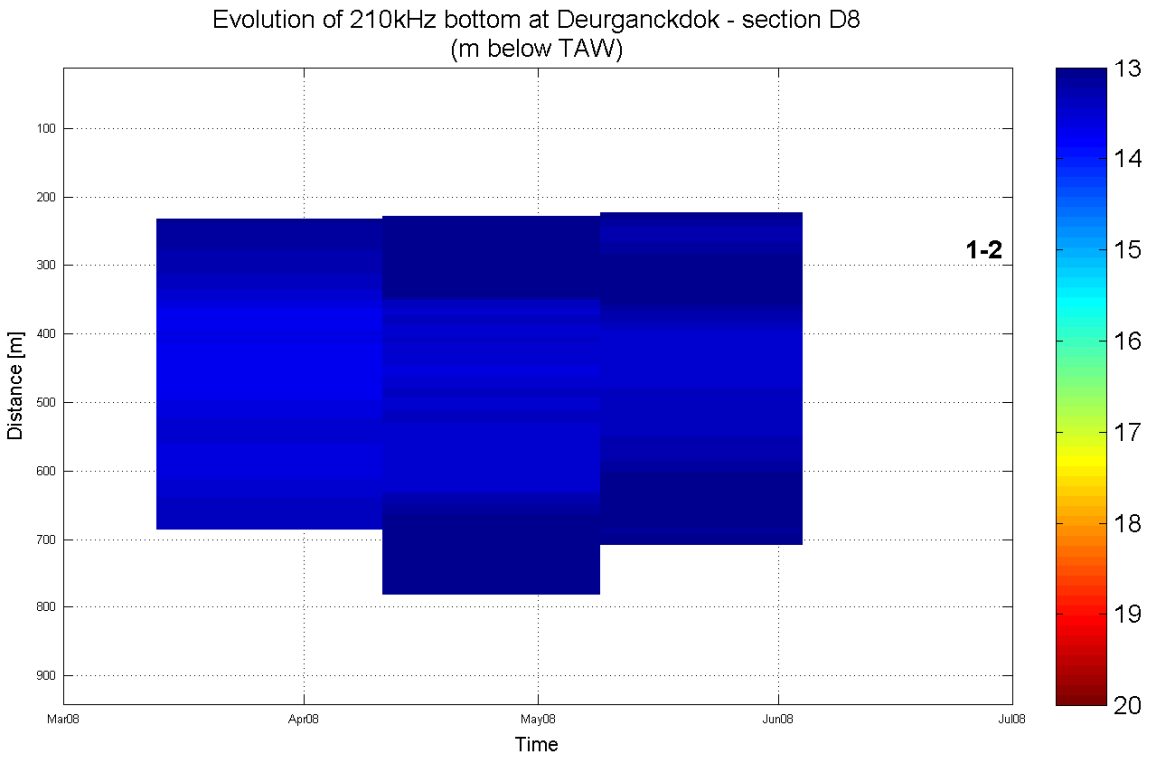
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



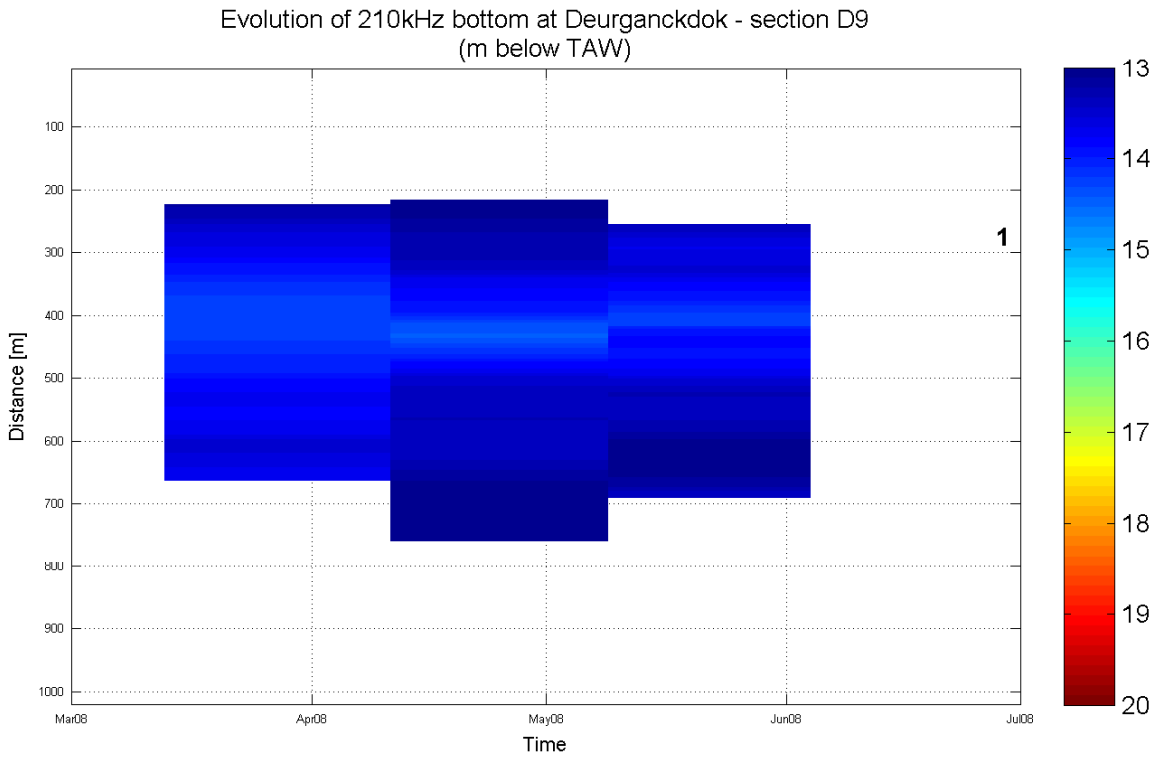
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



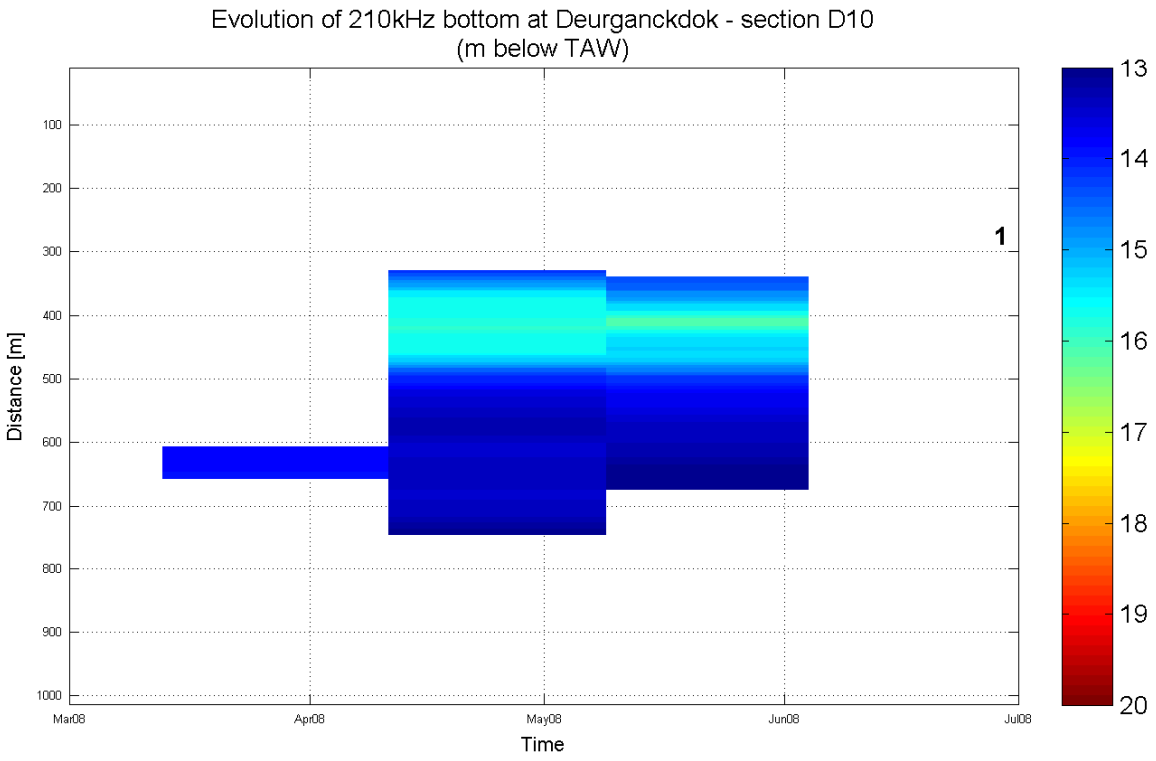
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



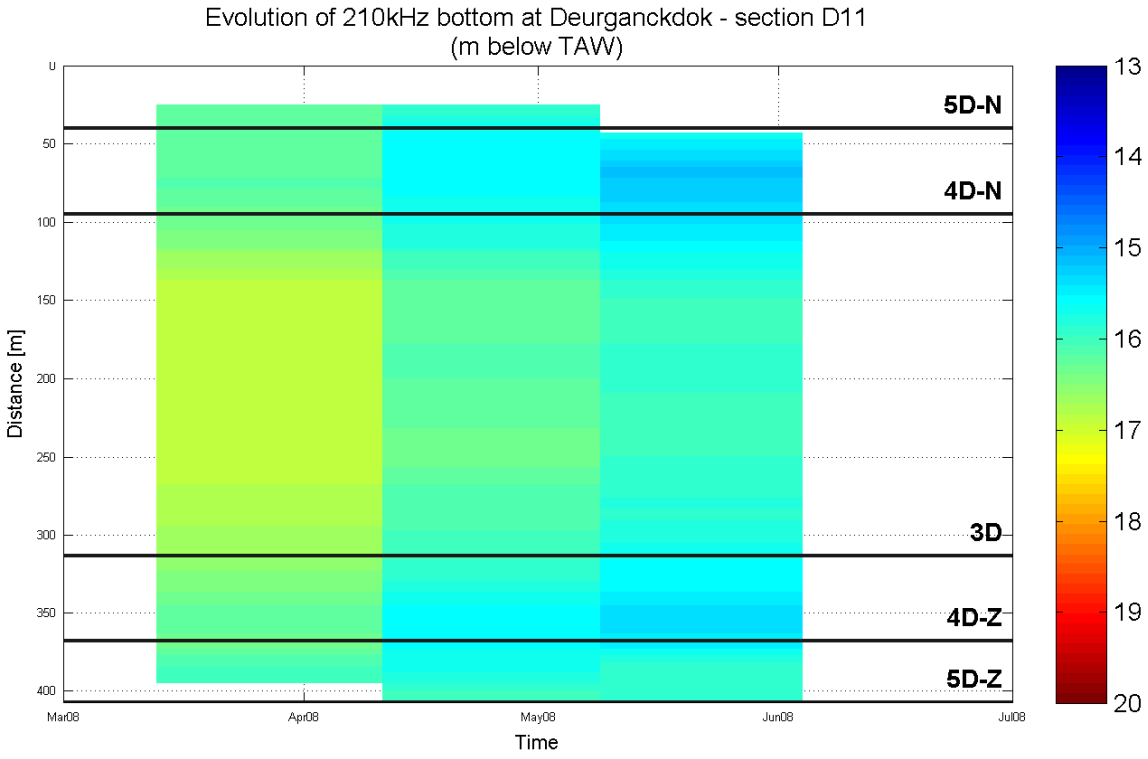
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



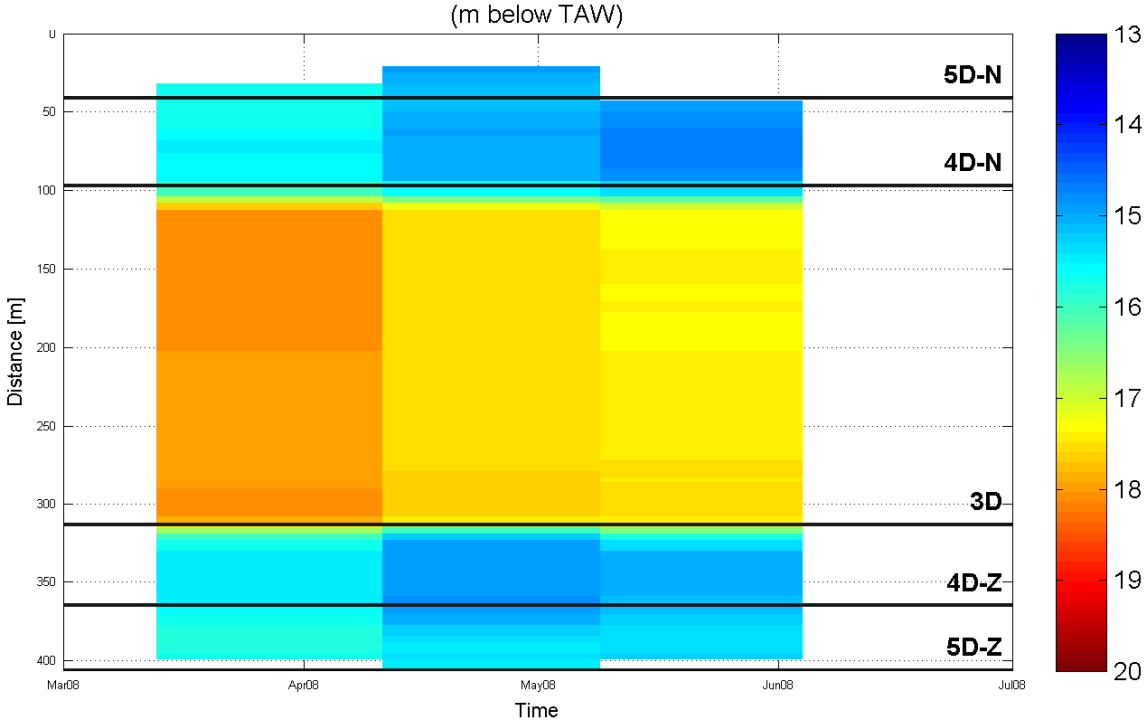
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



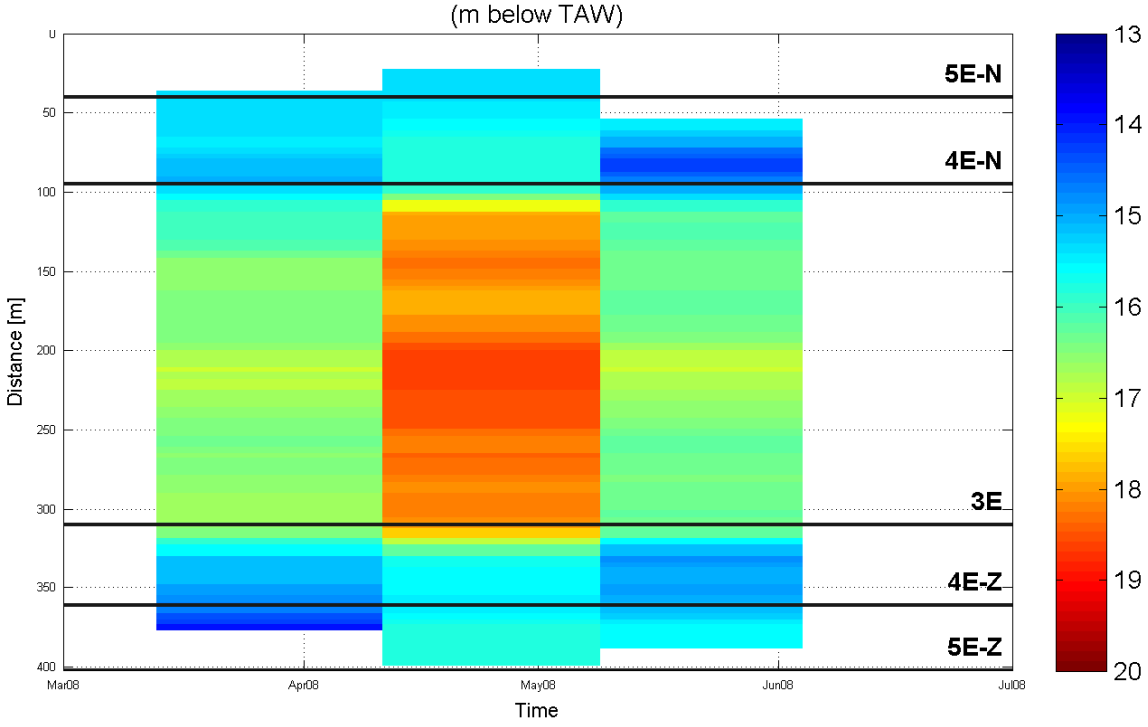
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



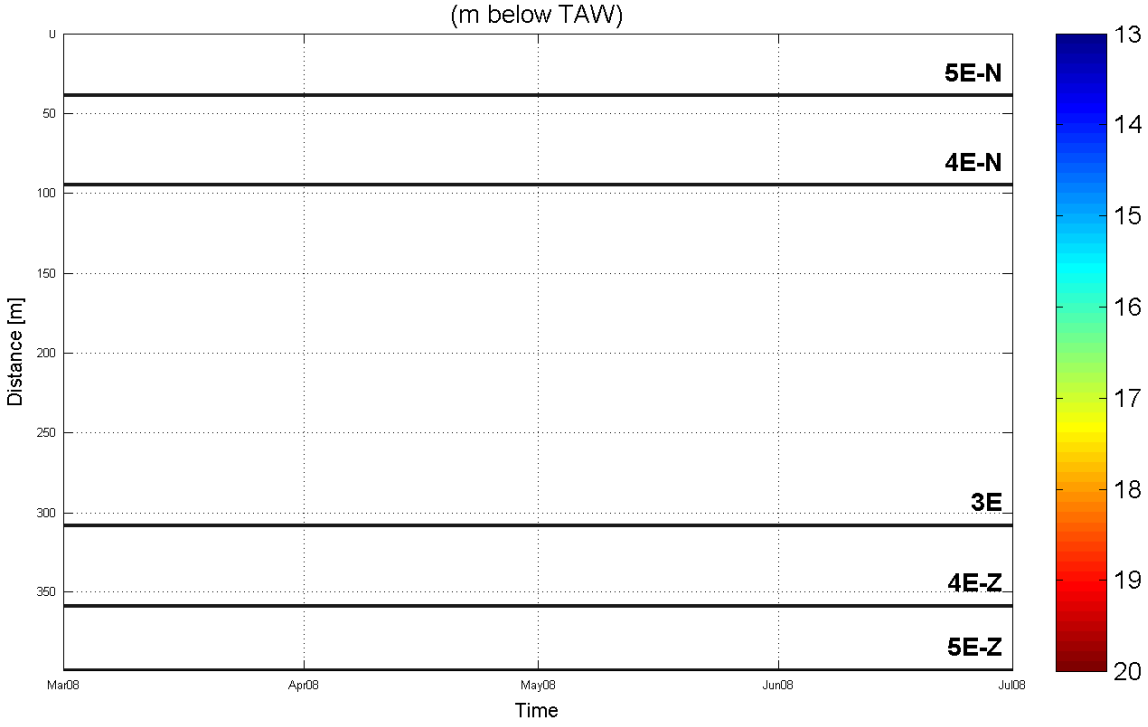
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



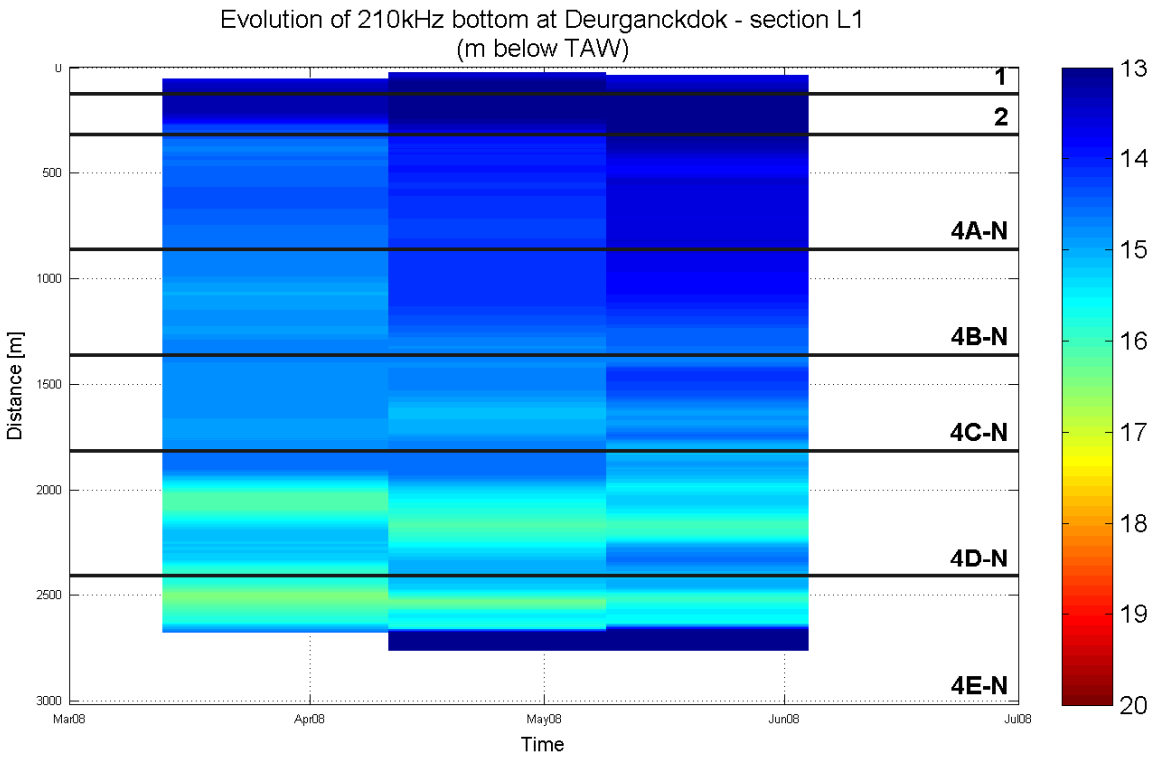
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



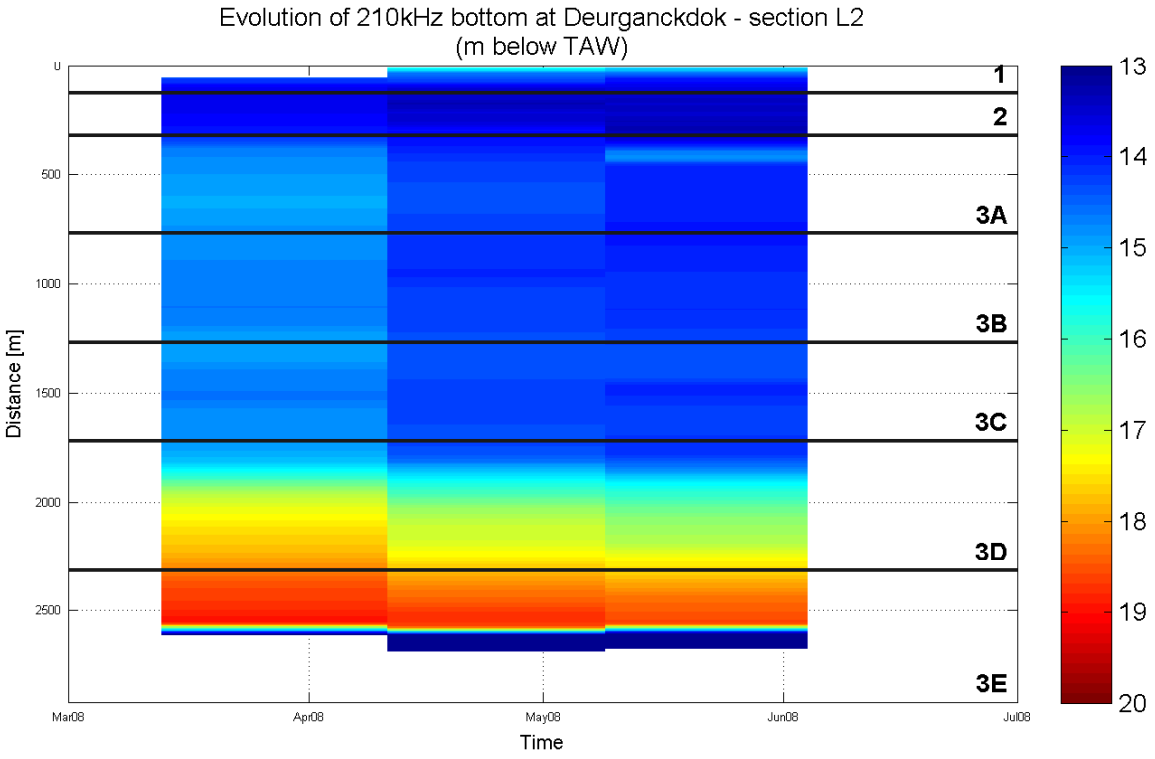
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



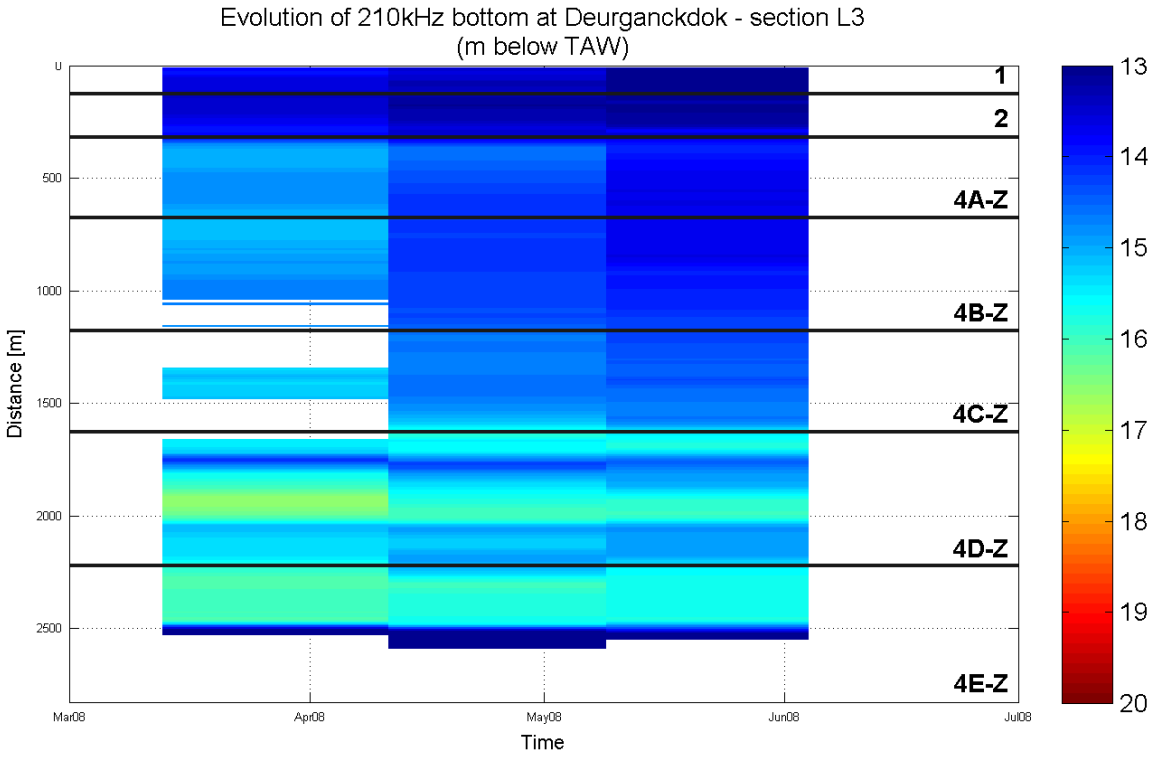
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



Data Processed by:

In association with :

I/RA/11283/08.076/MSA

APPENDIX C.

VOLUMETRIC SILTATION RATES IN DIFFERENT ZONES AND SECTIONS

C.1 Siltation rates (tabular)

Siltation rates in cm/day

1/ Per zone

	11-Apr-08	09-May-08	04-Jun-08
1	0.95	-	-
2	2.11	-0.21	-0.72
3a	1.96	0.49	-4.23
3b	1.71	0.35	-4.43
3c	1.55	0.25	-4.19
3d	1.92	0.77	-0.86
3e	6.90	0.51	-
4Na	1.51	1.86	-3.44
4Nb	1.80	0.77	-3.68
4Nc	-0.23	0.97	-2.69
4Nd	0.30	0.18	0.23
4Ne	7.14	0.91	-
4Za	2.03	1.70	-3.64
4Zb	1.60	1.09	-3.40
4Zc	1.26	0.59	-2.15
4Zd	0.96	0.06	0.10
4Ze	4.98	-2.22	-
5Na	-	-	-
5Nb	-	-	-
5Nc	-1.92	-	-
5Nd	-0.42	-	-
5Ne	-	-	-
5Za	0.46	2.30	-
5Zb	0.04	1.81	-
5Zc	-	0.77	-
5Zd	0.77	0.21	0.42
5Ze	4.51	-	-

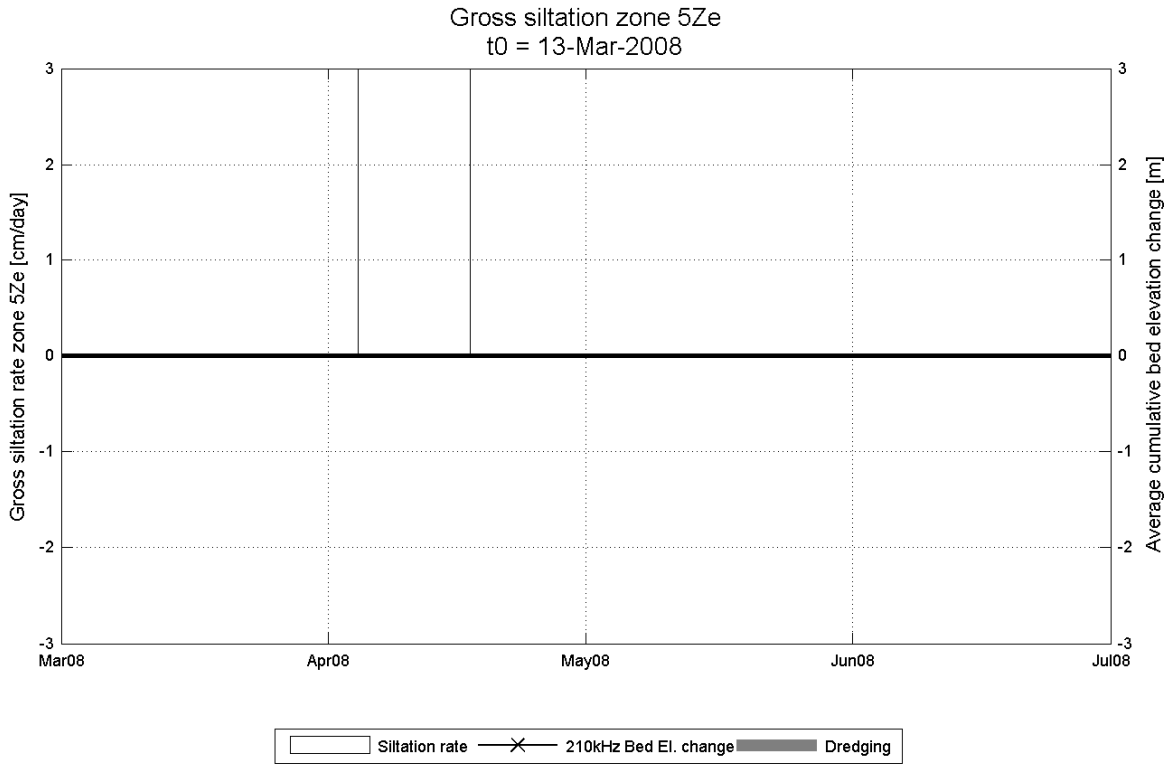
2/ Per section

	11-Apr-08	09-May-08	04-Jun-08
D1	0.60	0.90	-3.00
D2	1.11	0.58	-3.86
D3	1.52	0.47	-3.75
D4	1.94	1.18	-4.30
D5	1.61	1.63	-4.11
D6	1.35	1.30	-1.20
D7	2.19	-0.50	-0.88
D8	1.71	-	-
D9	1.40	-	-
D10	-	-	-
D11	2.09	0.82	-0.73
D12	2.00	-0.08	-0.44
D13	-3.95	4.14	-
D14	-	-	-
L1	1.72	0.88	-3.19
L2	2.19	0.42	-3.05
L3	1.76	0.50	-2.24

C.2 Water-bed interface evolution for all zones

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 13-Mar-2008

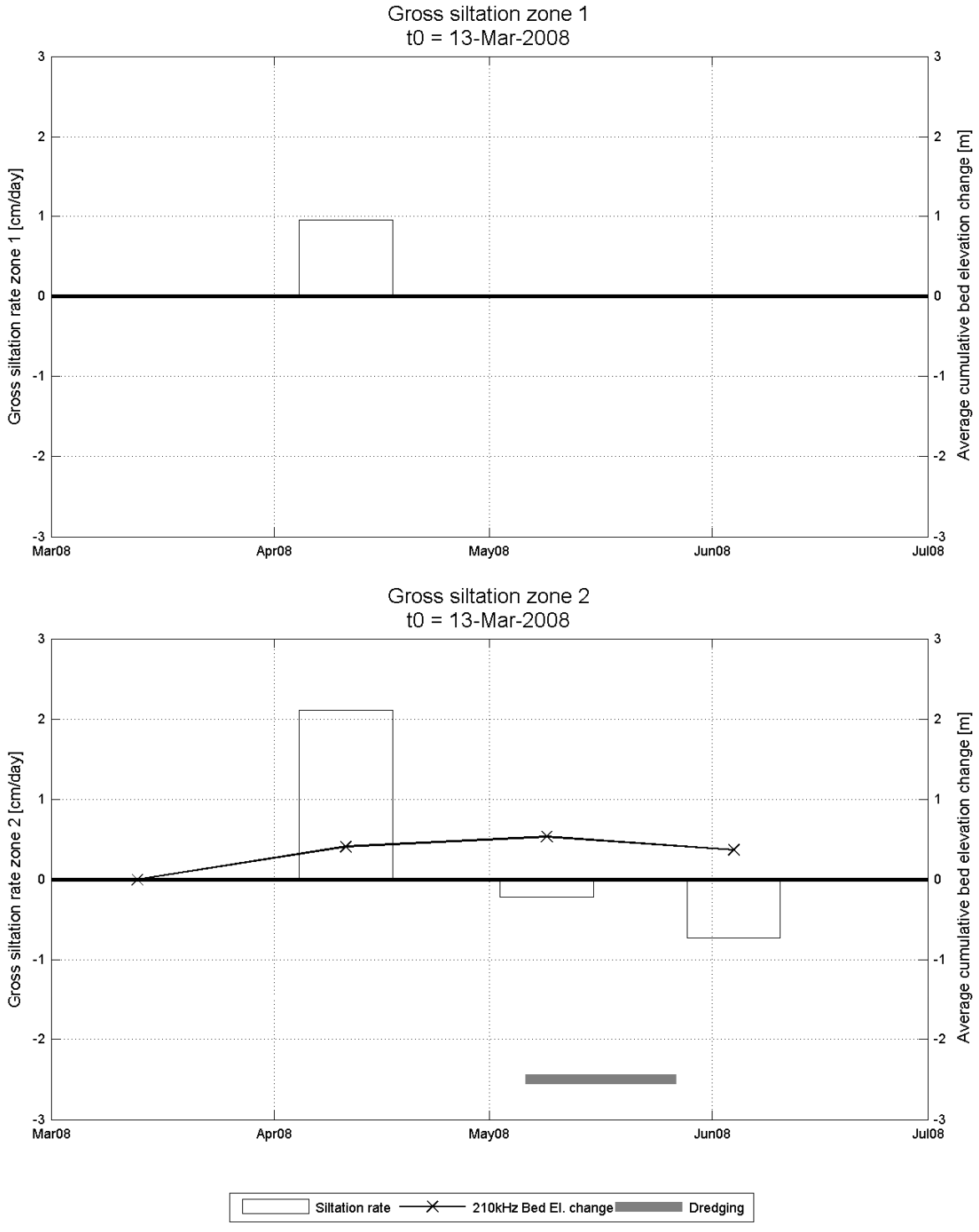
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 13-Mar-2008

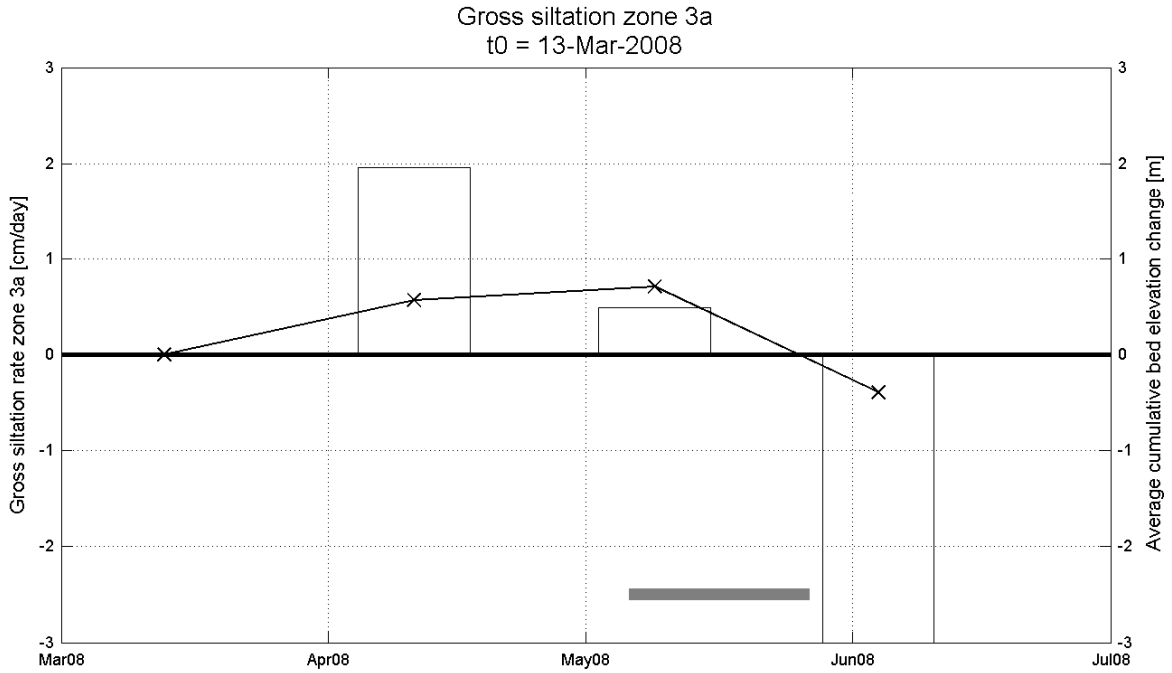
Data Processed by: IMDC

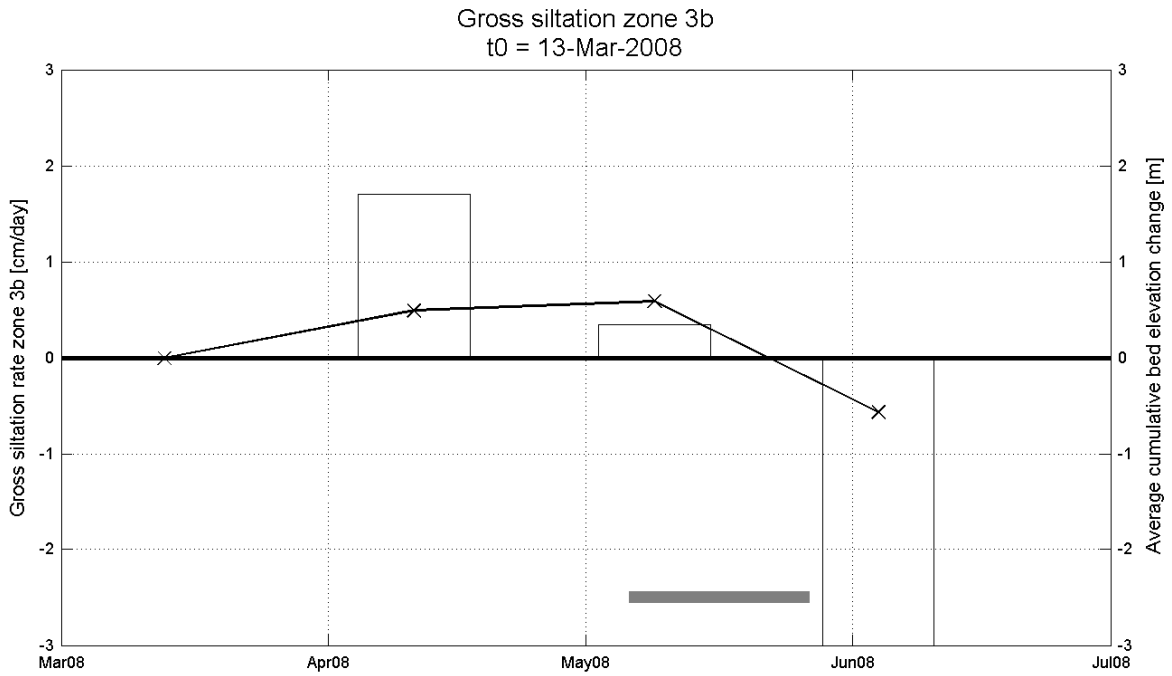
In association with : WL | delft hydraulics

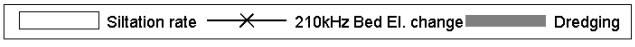
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

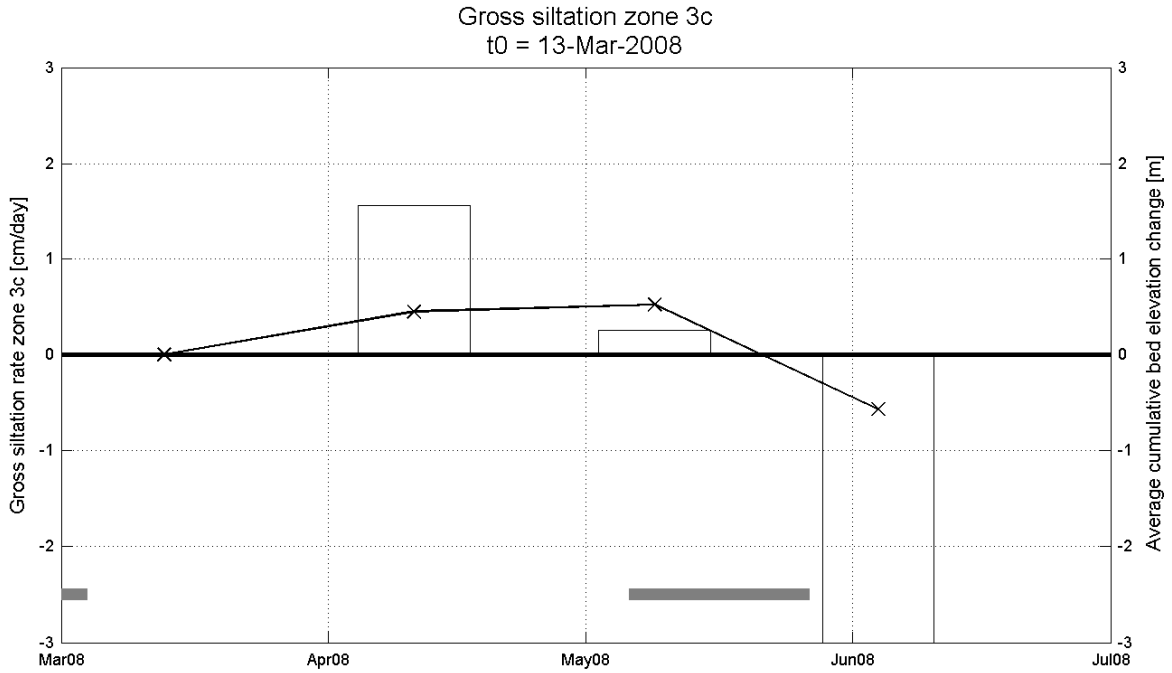
Data Processed by: IMDC

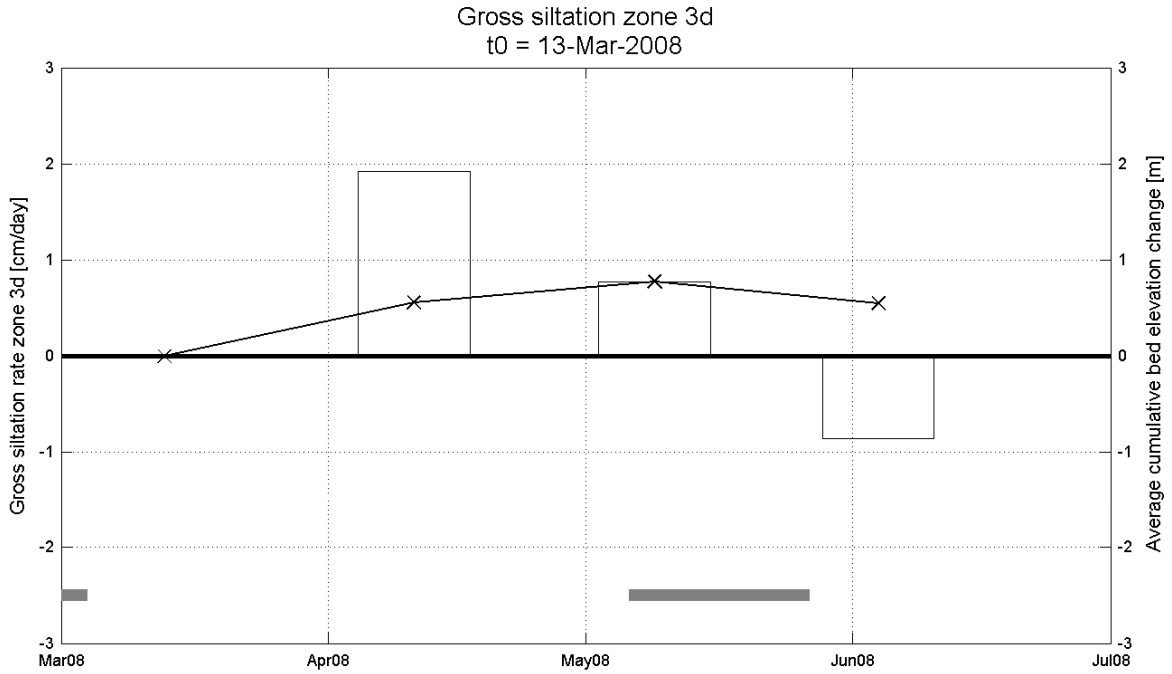
In association with : WL | delft hydraulics

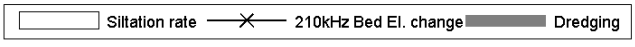
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

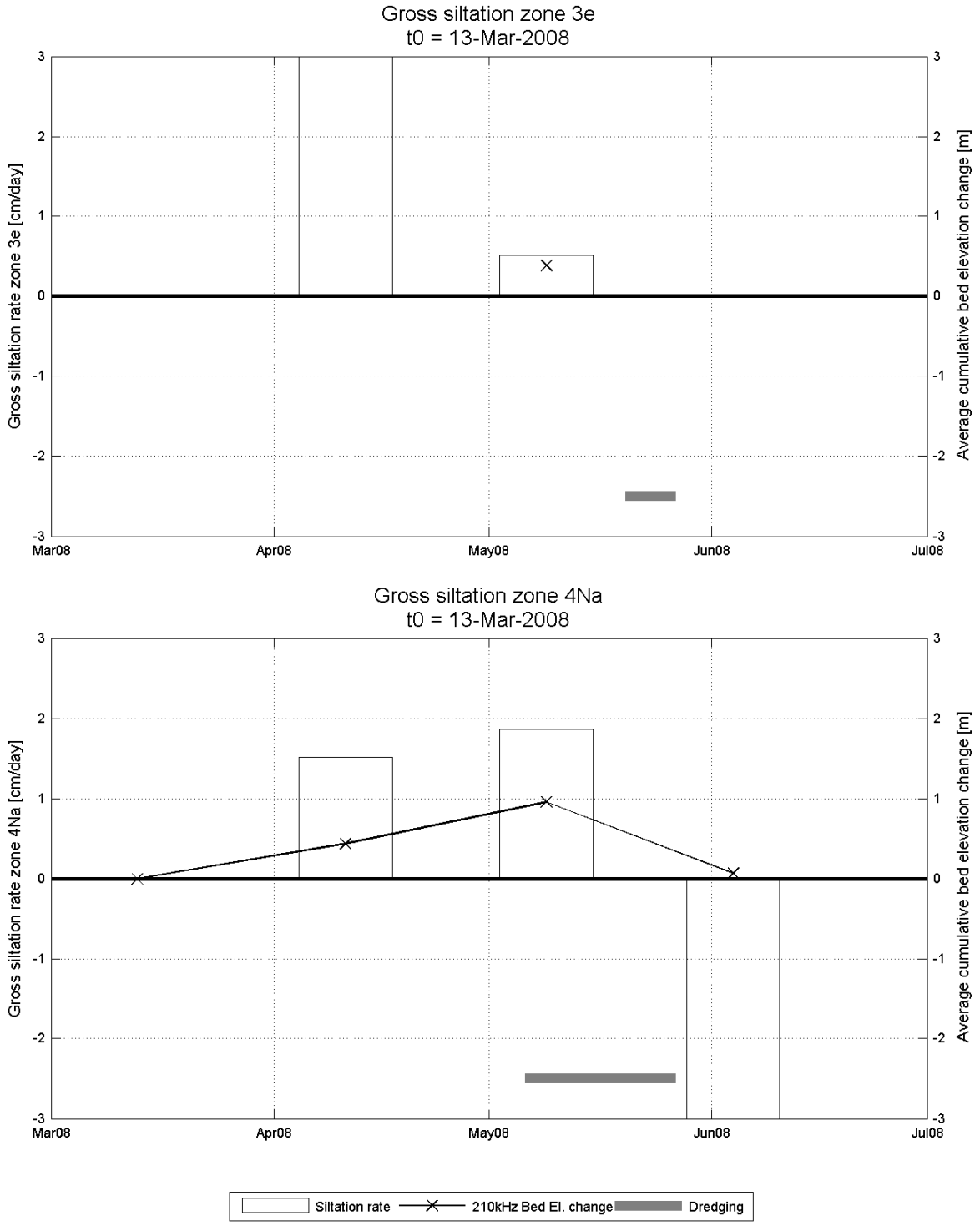
Data Processed by: IMDC

In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 13-Mar-2008

Data Processed by: IMDC

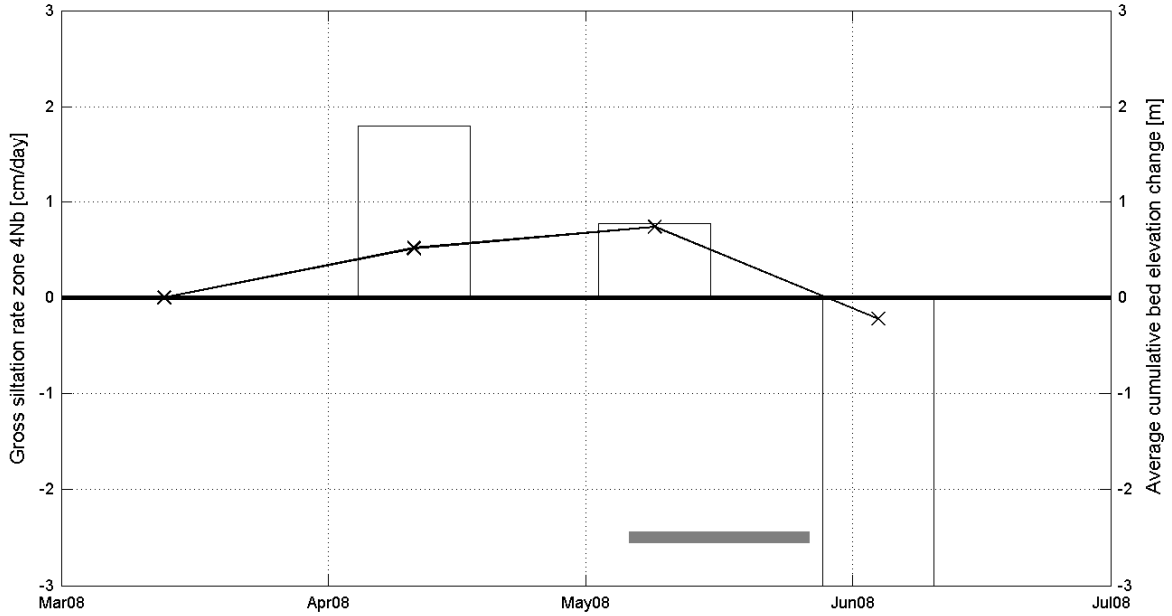
In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

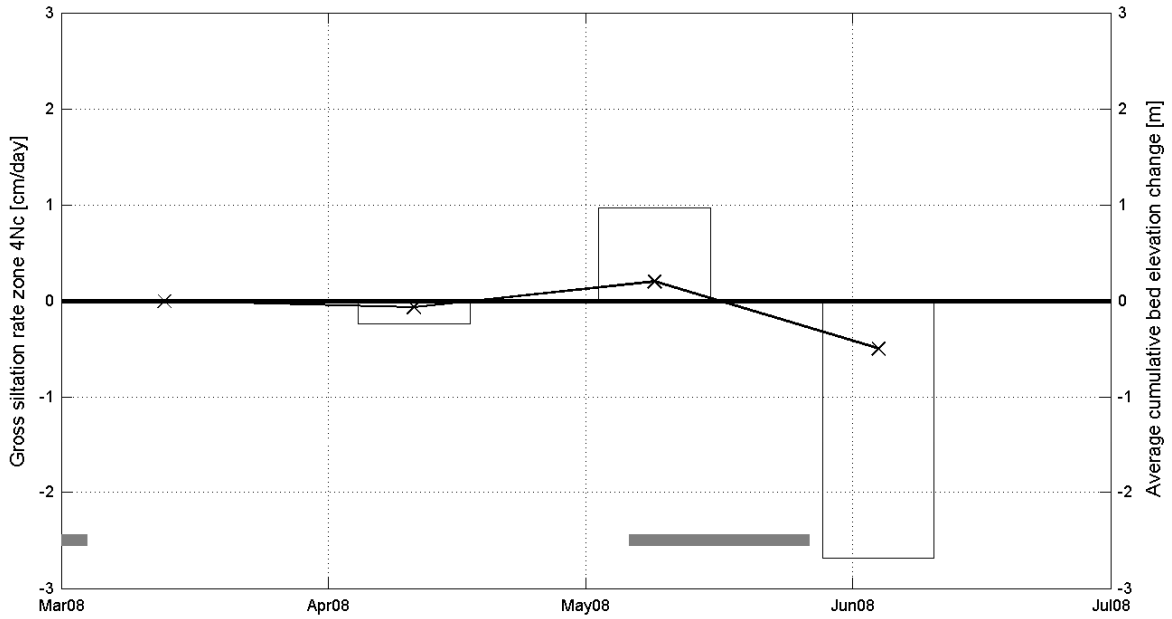
Long-term monitoring siltation Deurganckdok

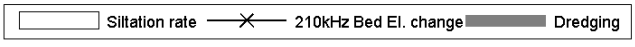
Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation zone 4Nb
t0 = 13-Mar-2008



Gross siltation zone 4Nc
t0 = 13-Mar-2008





Reference level: depth sounding 13-Mar-2008

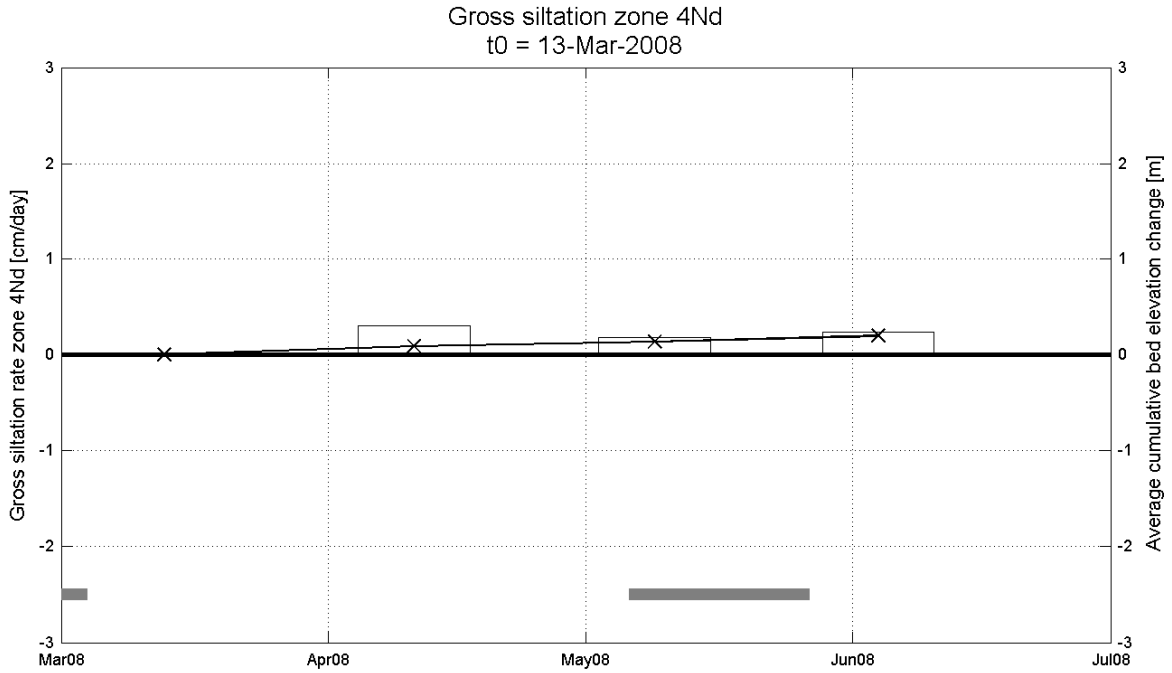
Data Processed by:

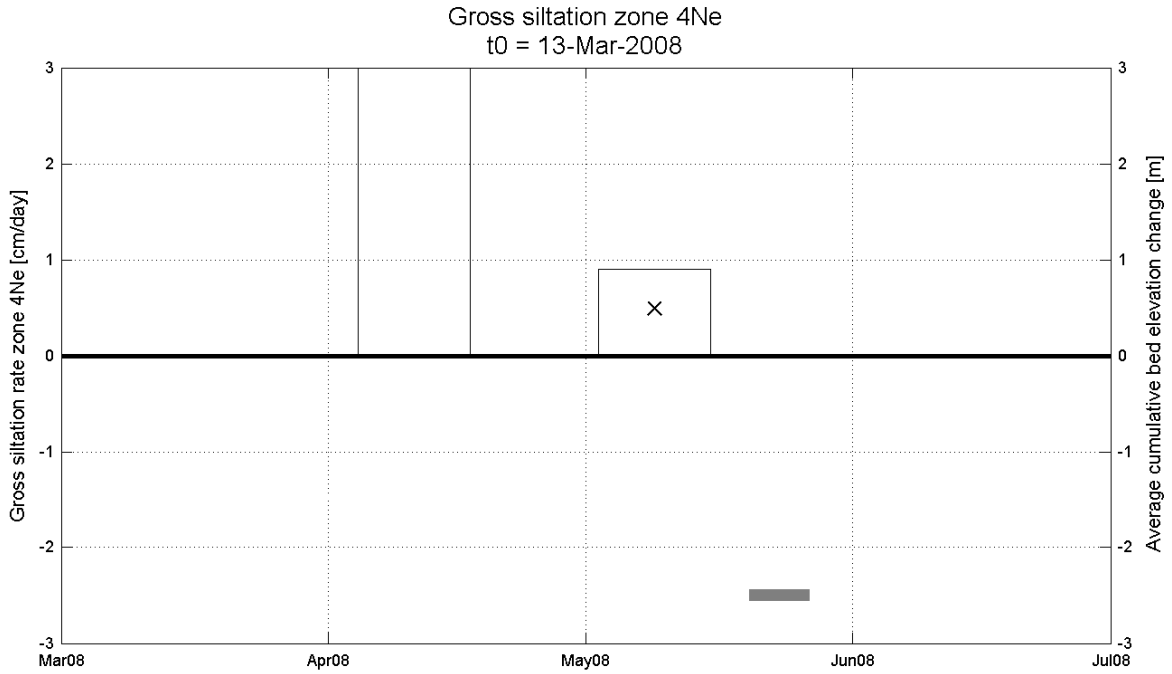
In association with :

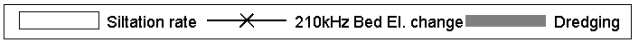
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

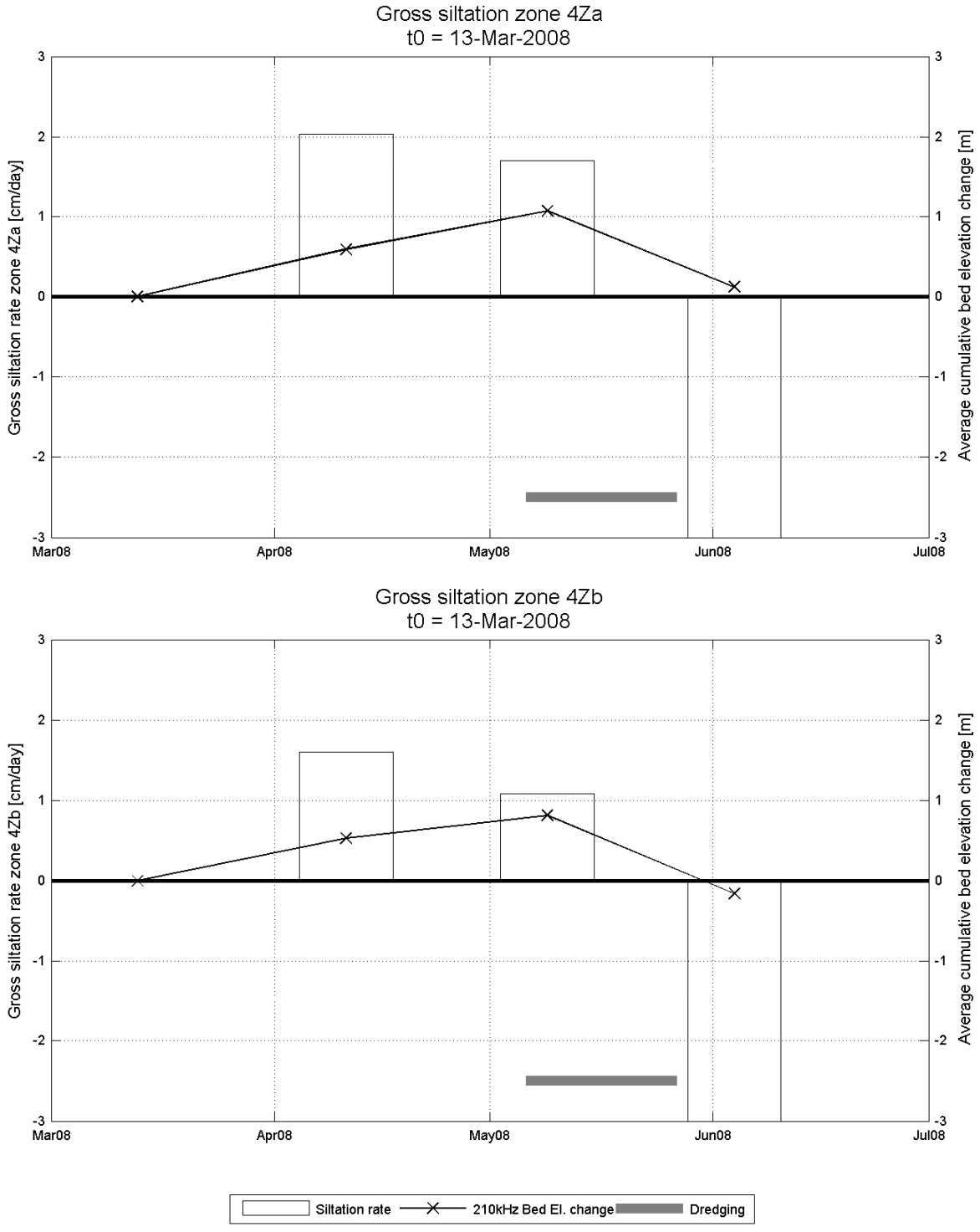
Data Processed by: IMDC

In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 13-Mar-2008

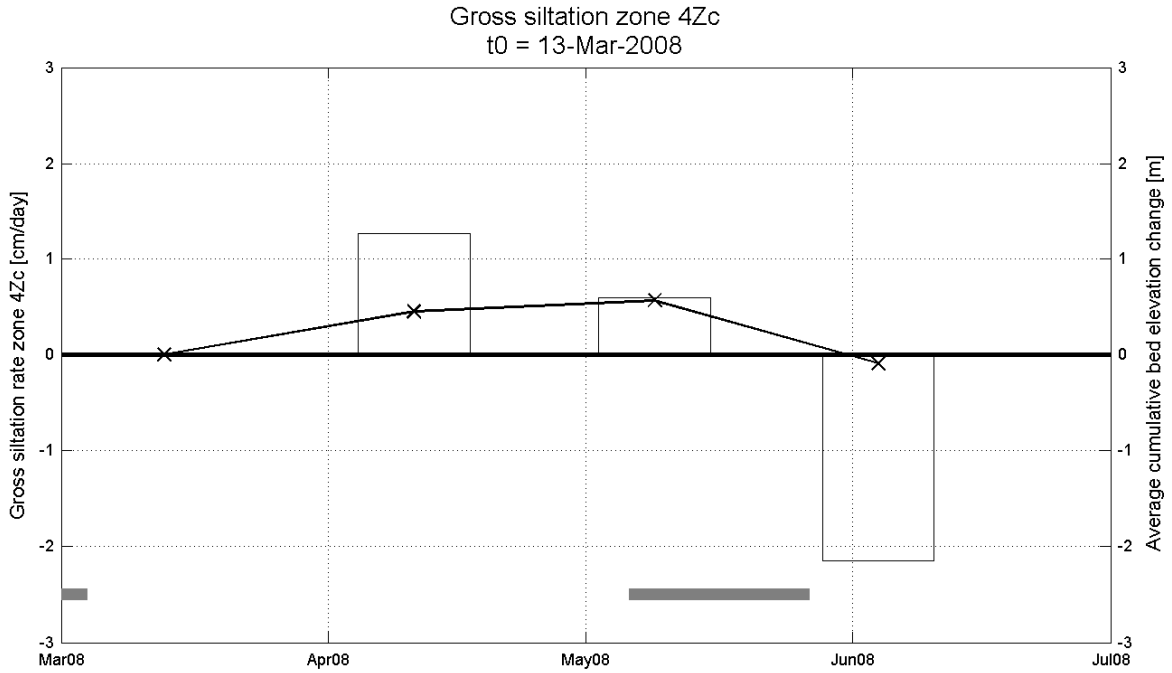
Data Processed by: IMDC

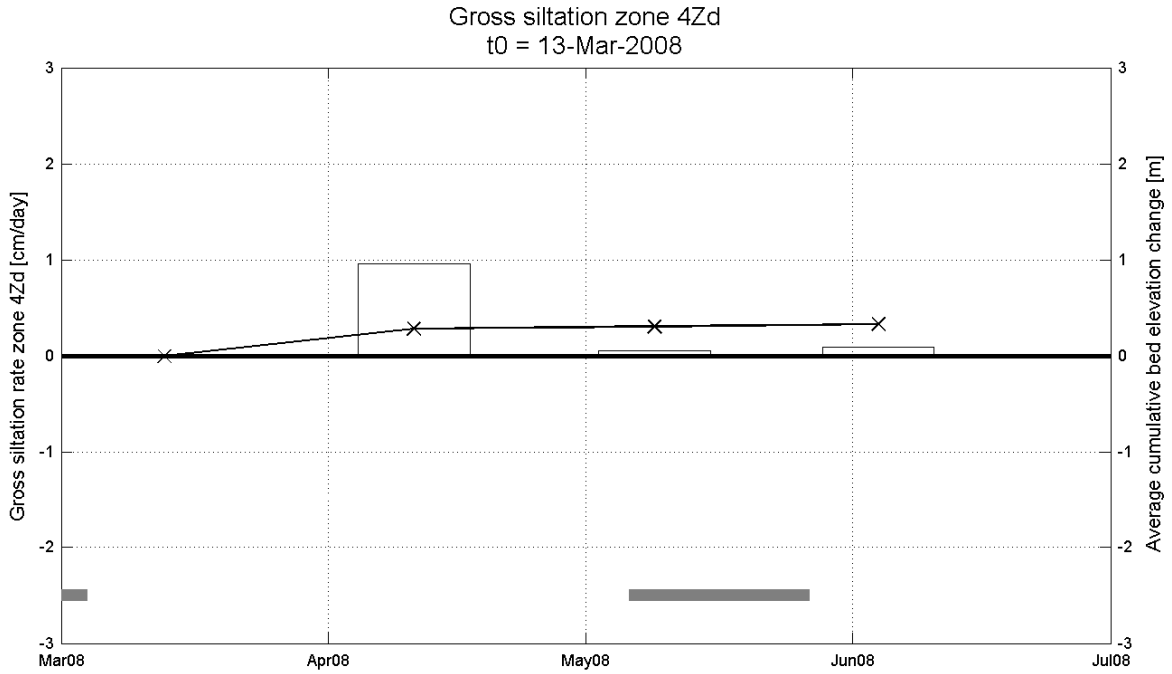
In association with : WL | delft hydraulics

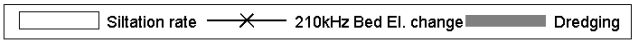
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

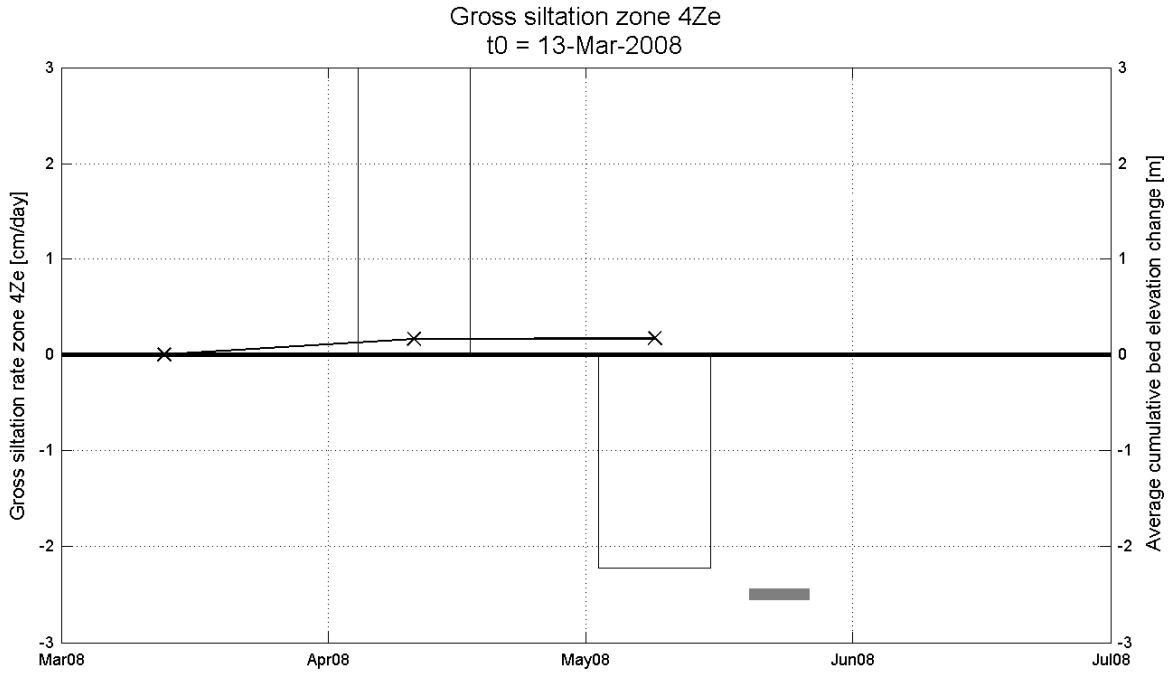
Data Processed by: IMDC

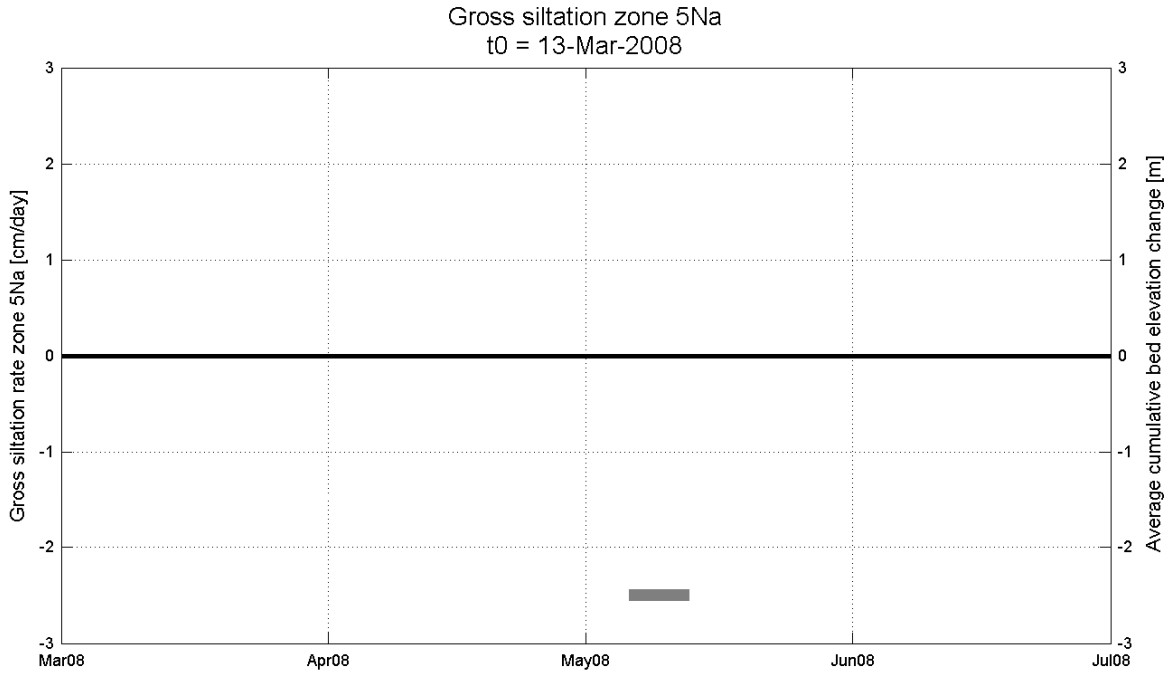
In association with : WL | delft hydraulics

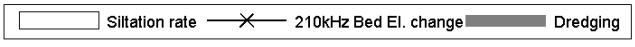
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

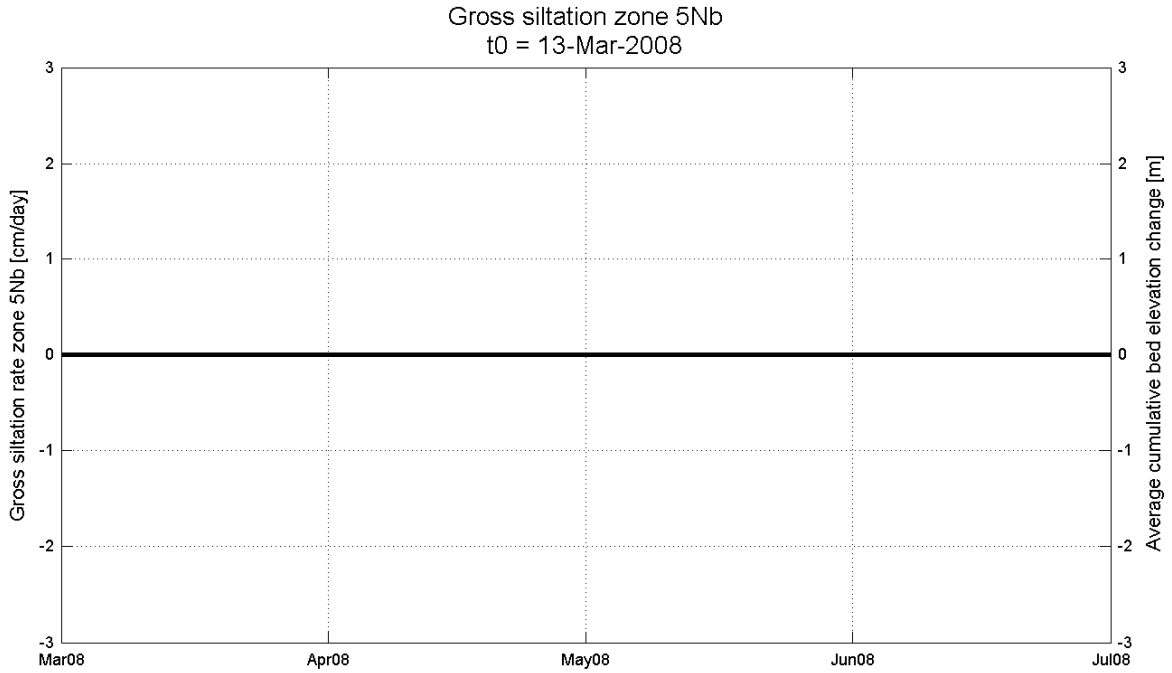
Data Processed by: IMDC

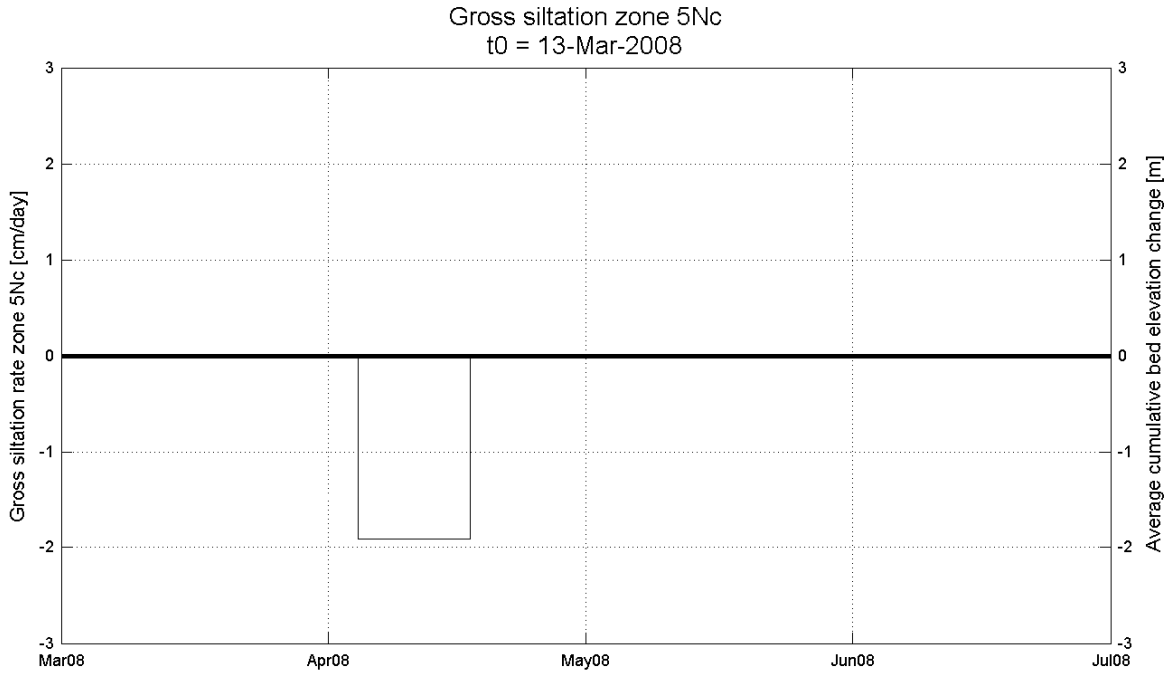
In association with : WL | delft hydraulics

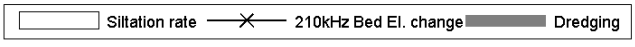
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

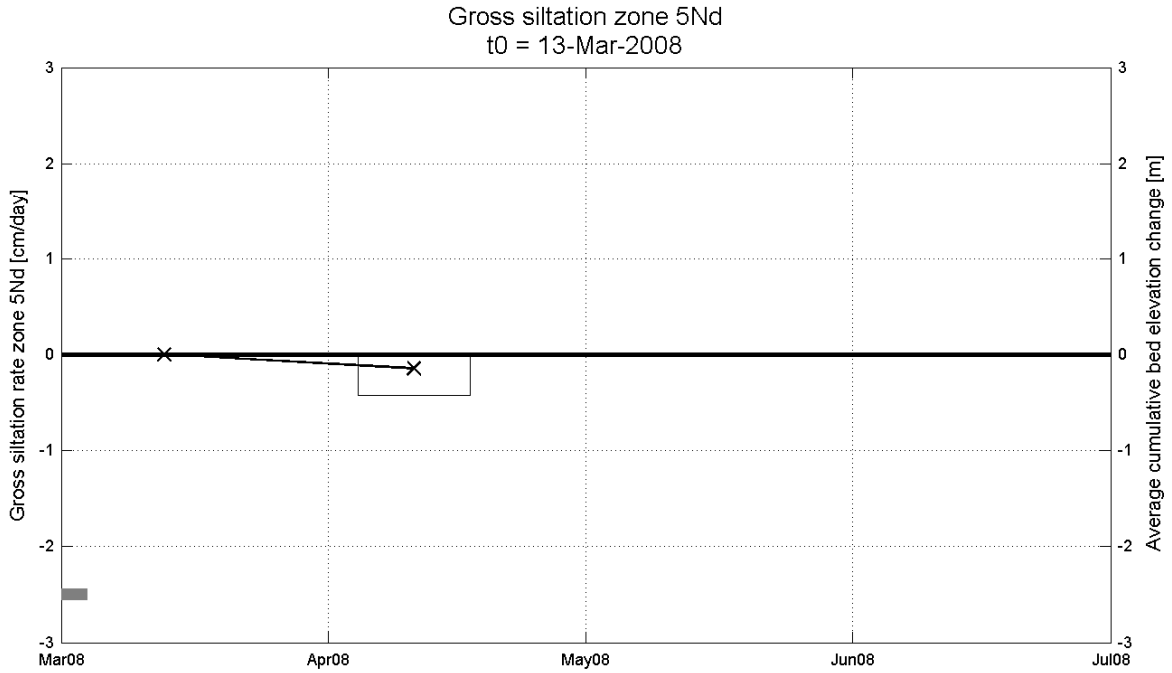
Data Processed by:

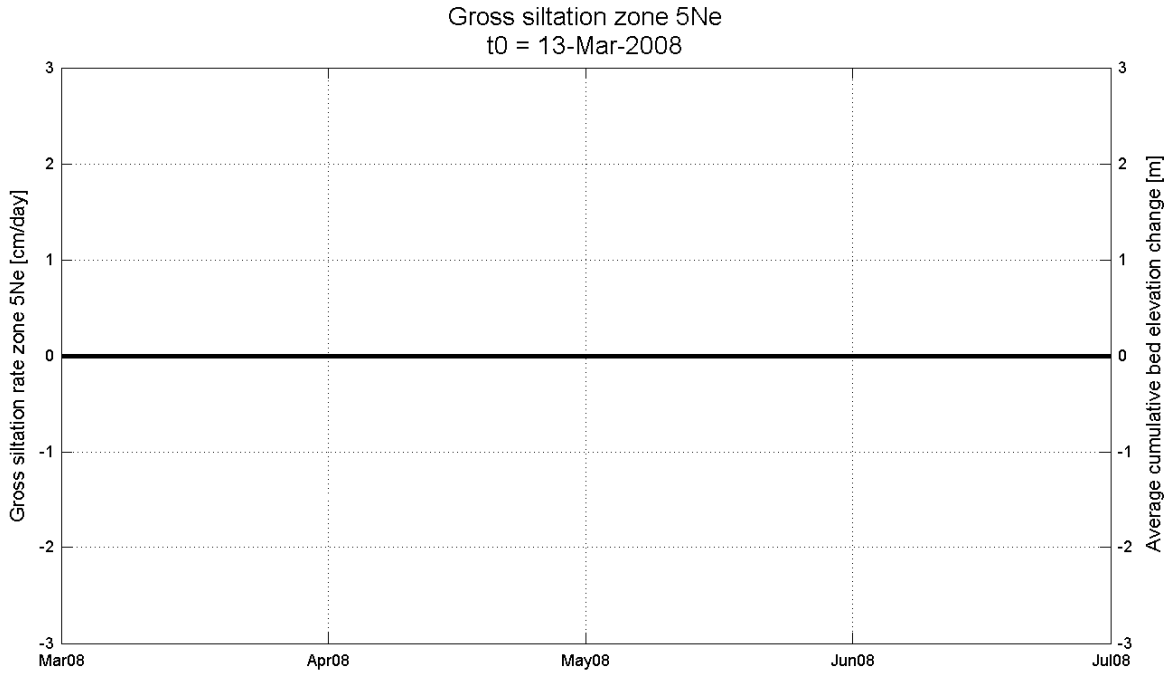
In association with :

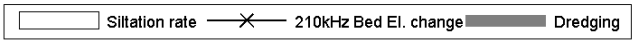
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

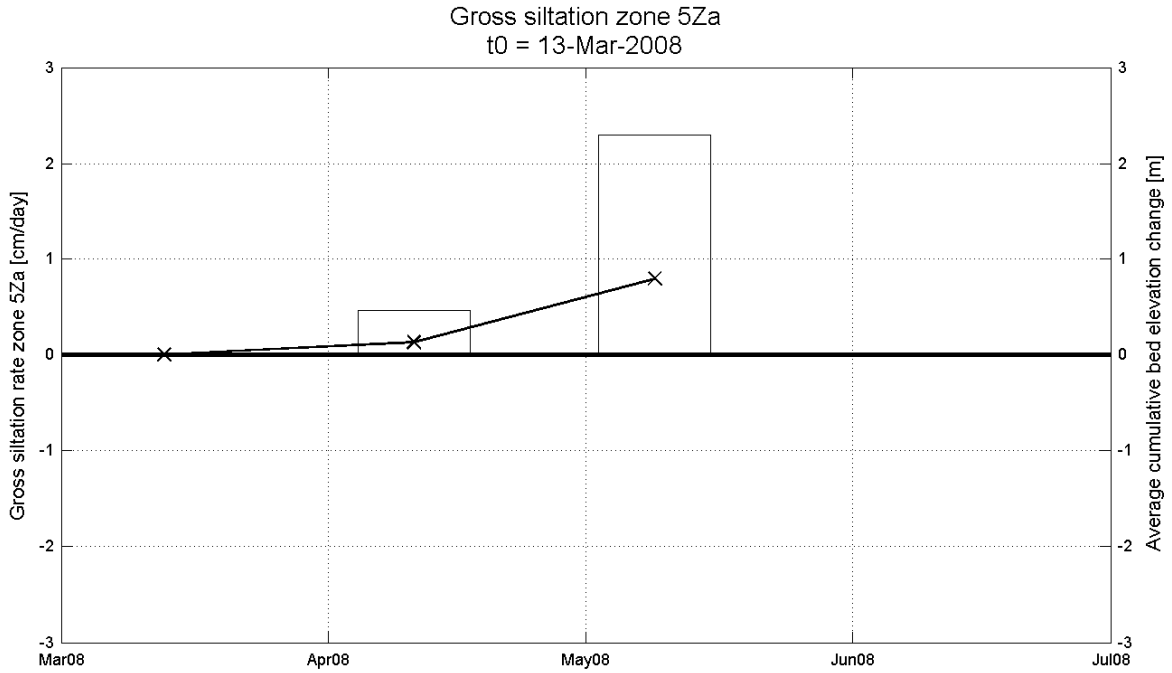
Data Processed by: IMDC

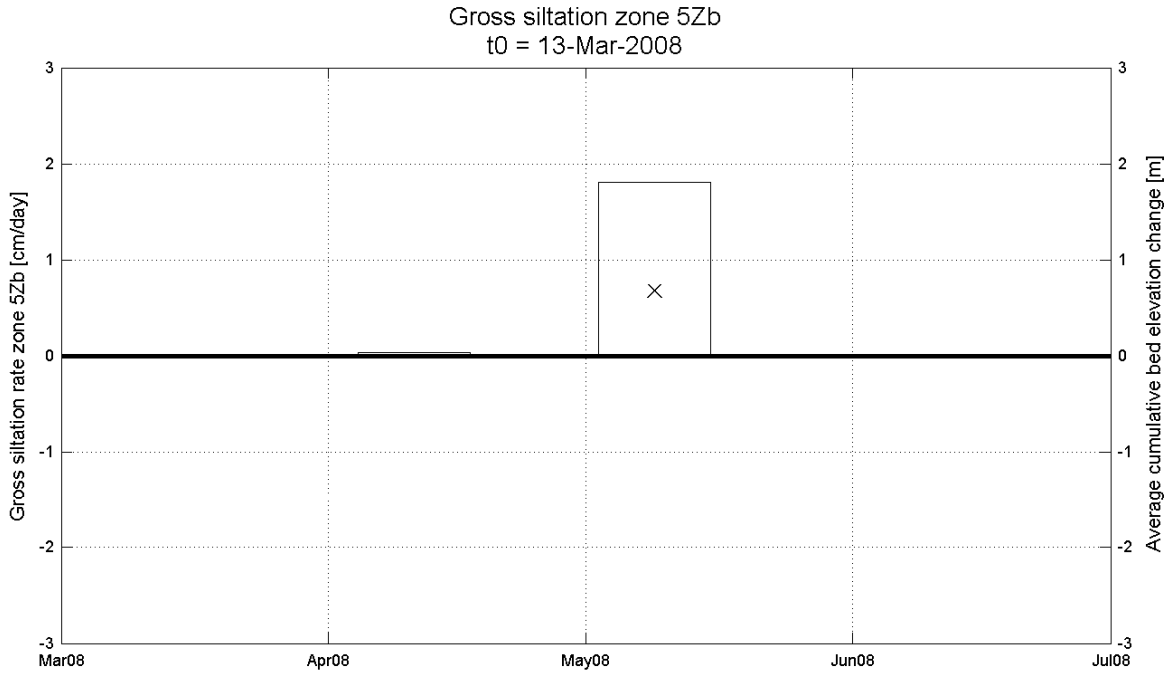
In association with : WL | delft hydraulics

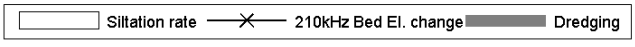
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

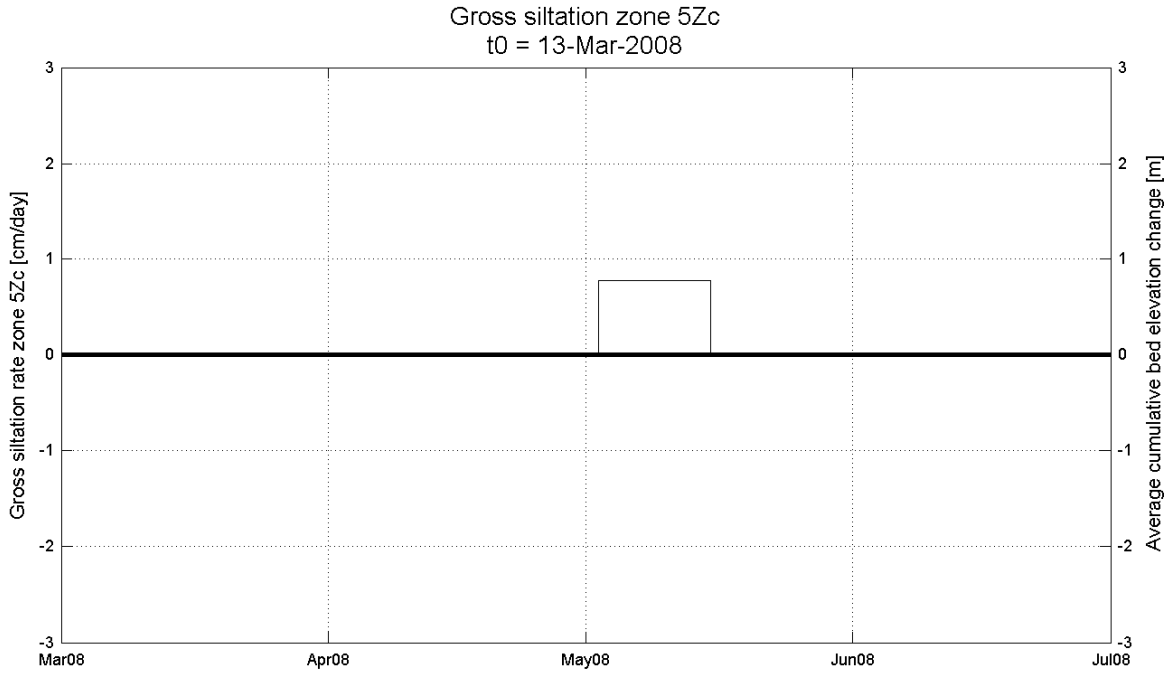
Data Processed by: IMDC

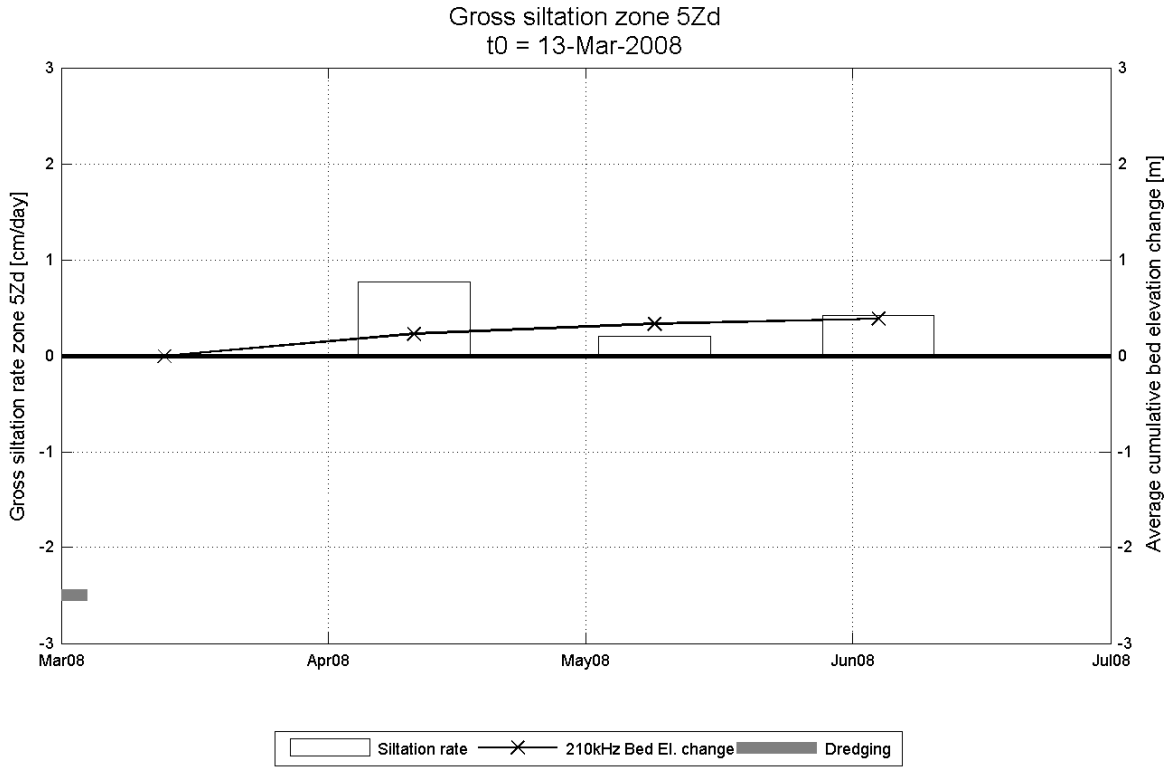
In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 13-Mar-2008

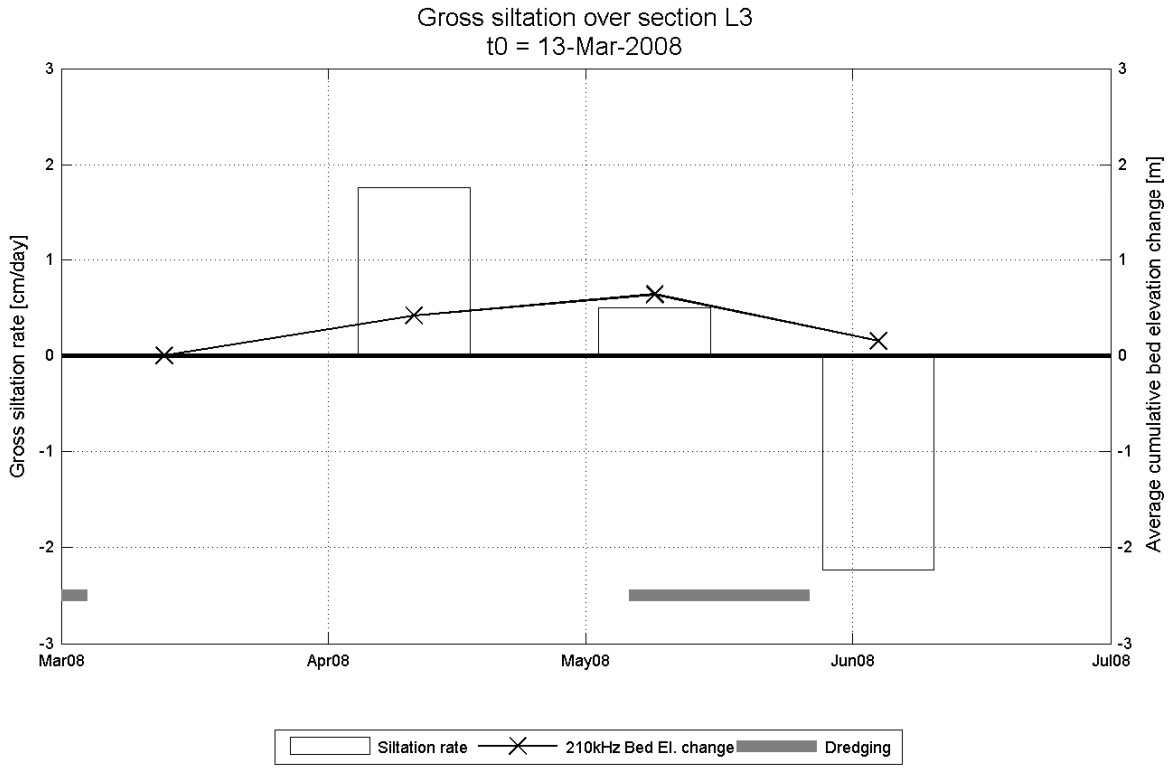
Data Processed by: IMDC
In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

C.3 Water-bed interface evolution for all sections

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 13-Mar-2008

Data Processed by:

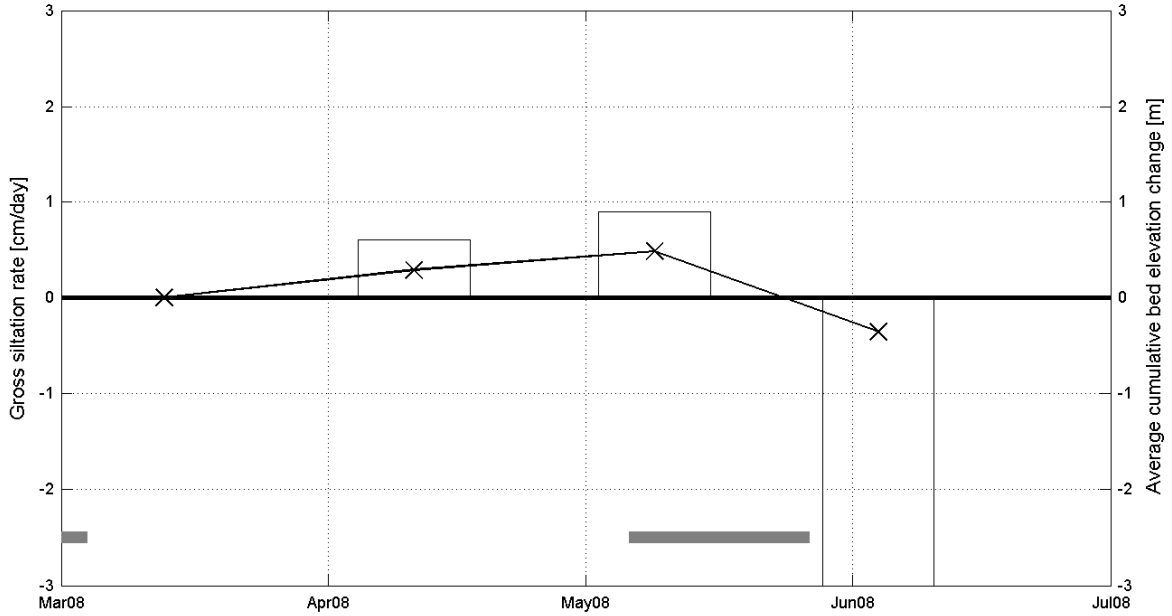
In association with :

I/RA/11283/08.076/MSA

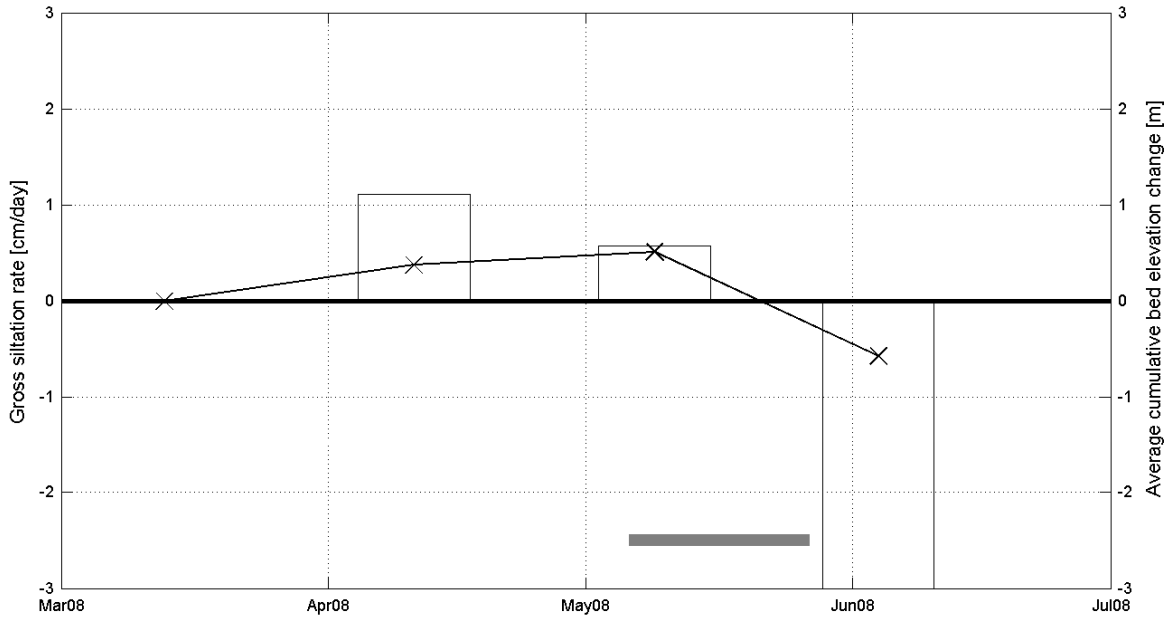
Long-term monitoring siltation Deurganckdok

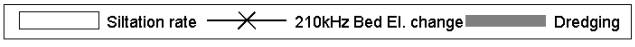
Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation over section D1
t0 = 13-Mar-2008



Gross siltation over section D2
t0 = 13-Mar-2008





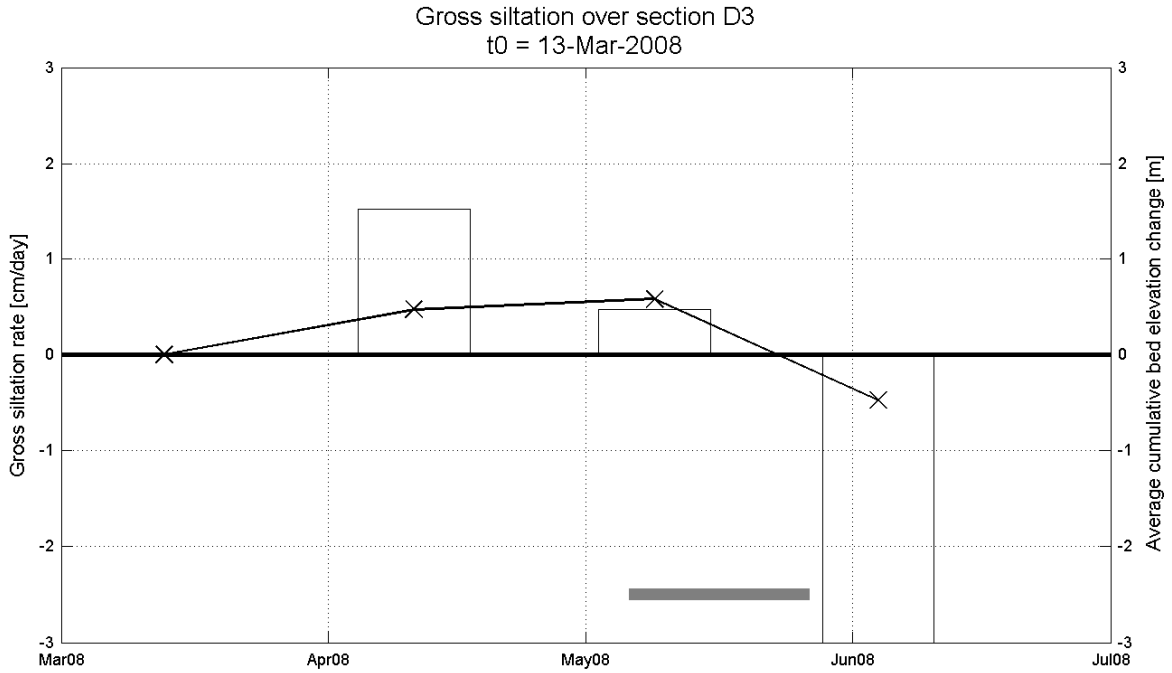
Reference level: depth sounding 13-Mar-2008

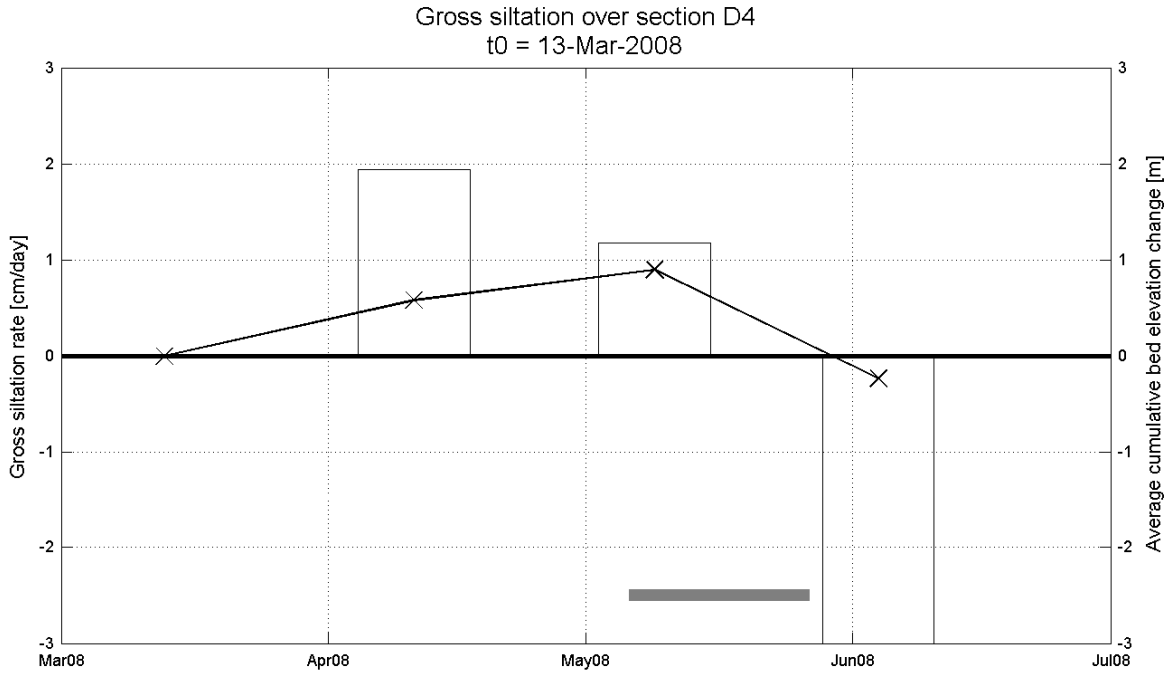
Data Processed by: IMDC
In association with : WL | delft hydraulics

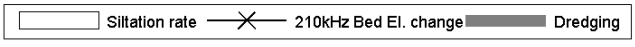
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

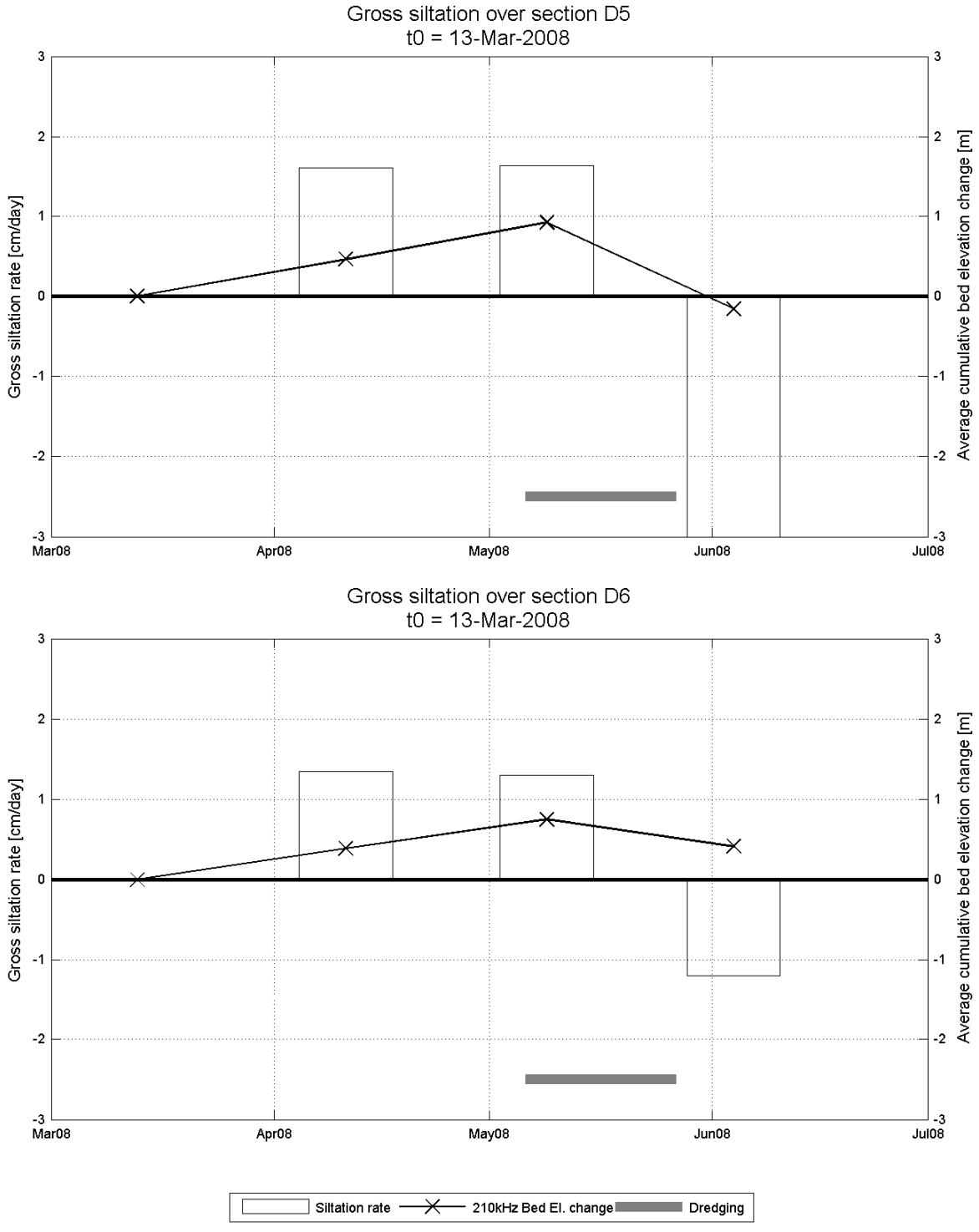
Data Processed by: IMDC

In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 13-Mar-2008

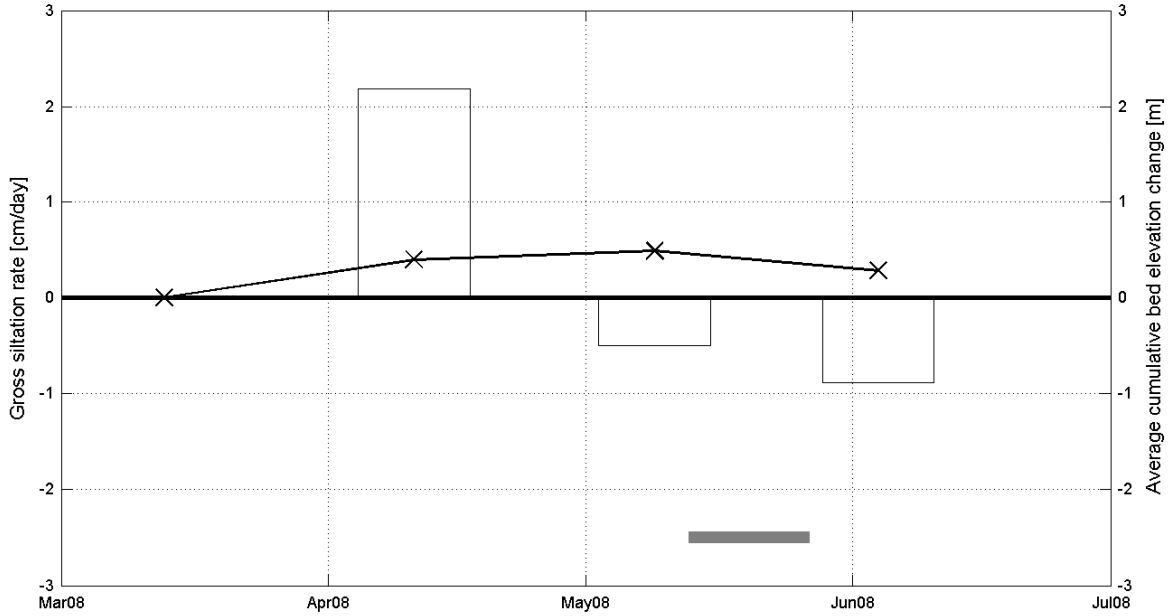
Data Processed by: IMDC
In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

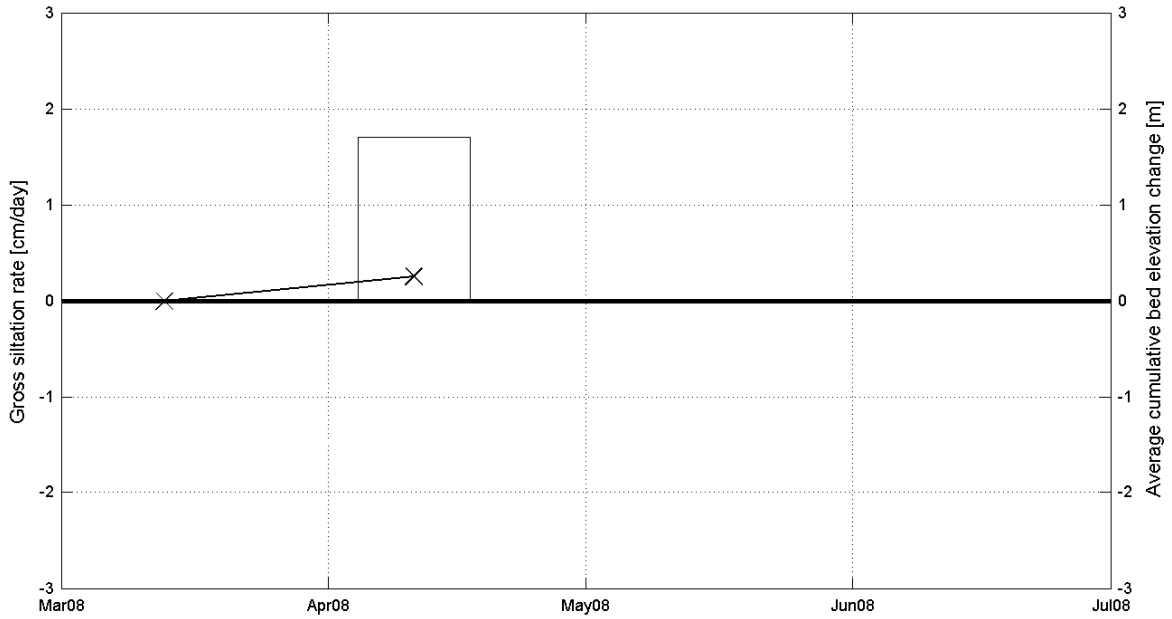
Long-term monitoring siltation Deurganckdok

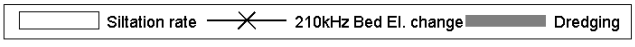
Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation over section D7
t0 = 13-Mar-2008



Gross siltation over section D8
t0 = 13-Mar-2008





Reference level: depth sounding 13-Mar-2008

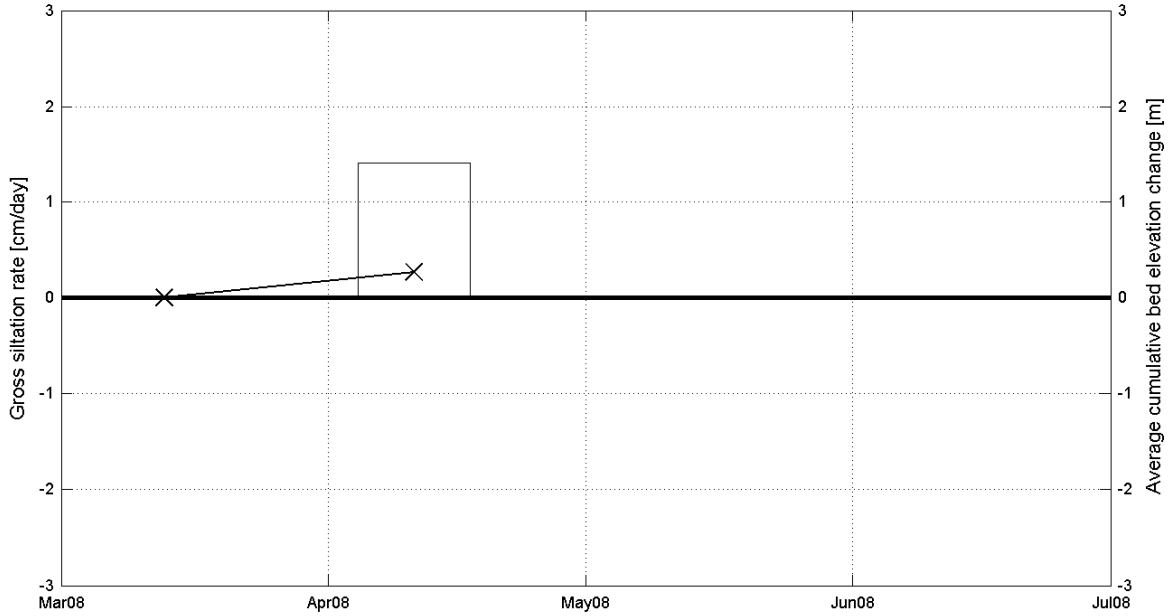
Data Processed by: IMDC
In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

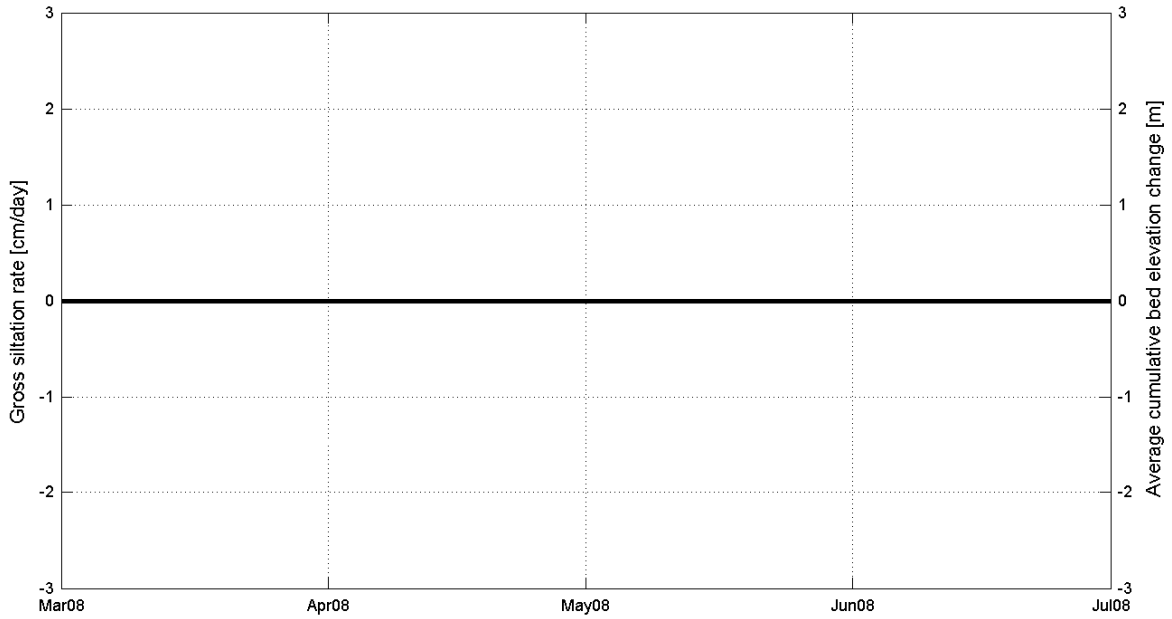
Long-term monitoring siltation Deurganckdok

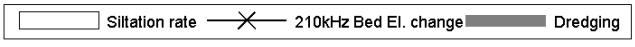
Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation over section D9
t0 = 13-Mar-2008



Gross siltation over section D10
t0 = 13-Mar-2008





Reference level: depth sounding 13-Mar-2008

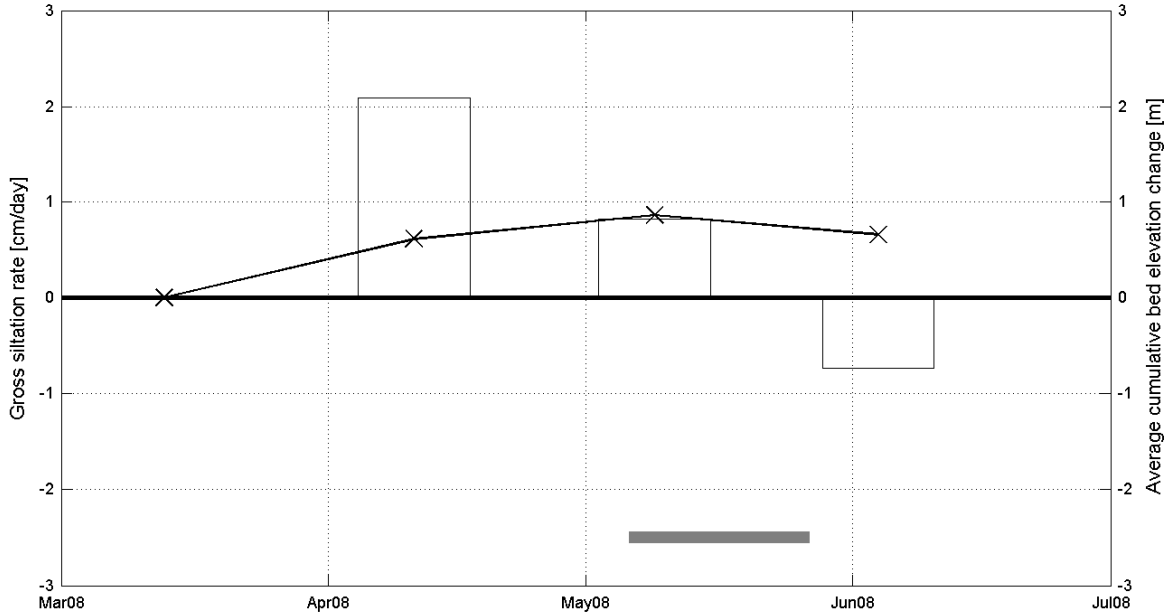
Data Processed by:

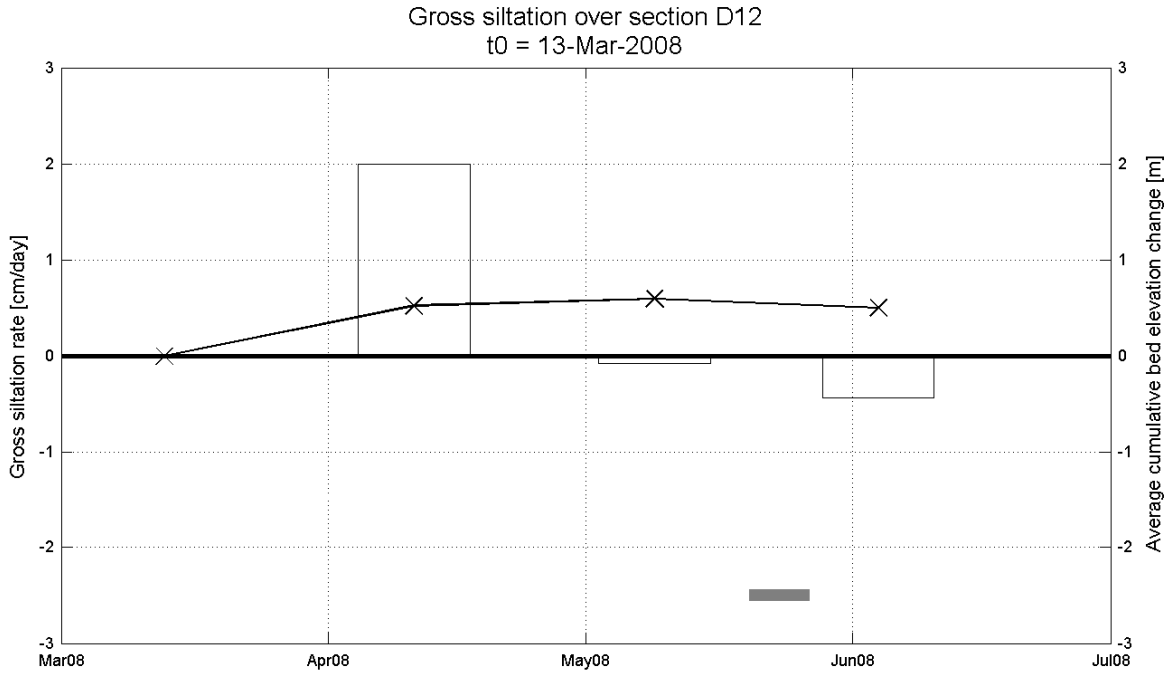
In association with :

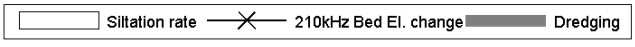
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

Data Processed by: IMDC

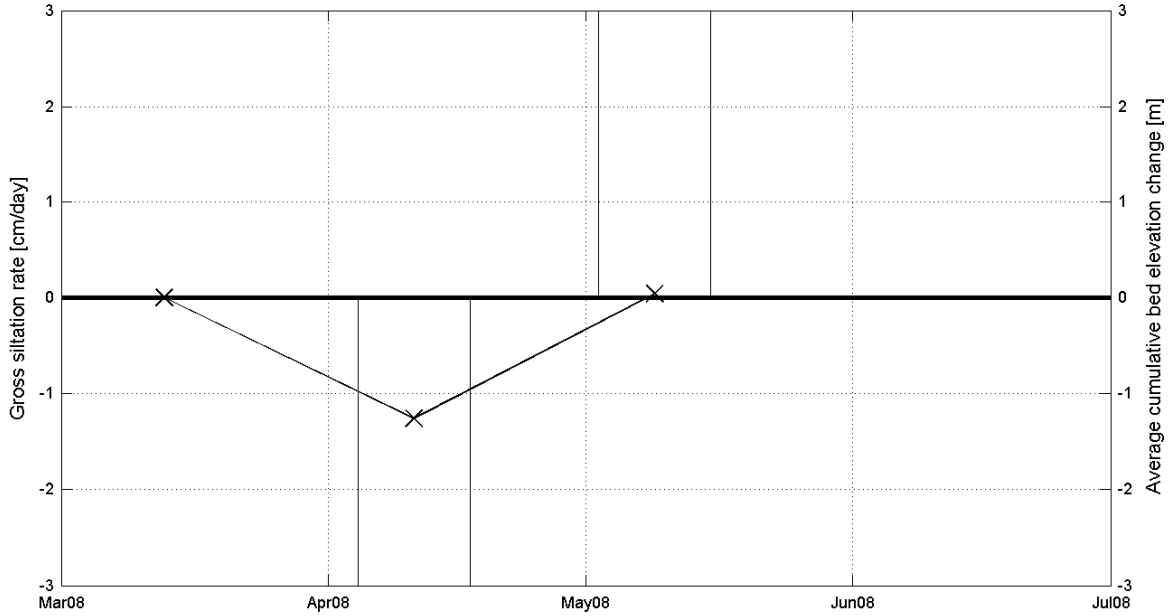
In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

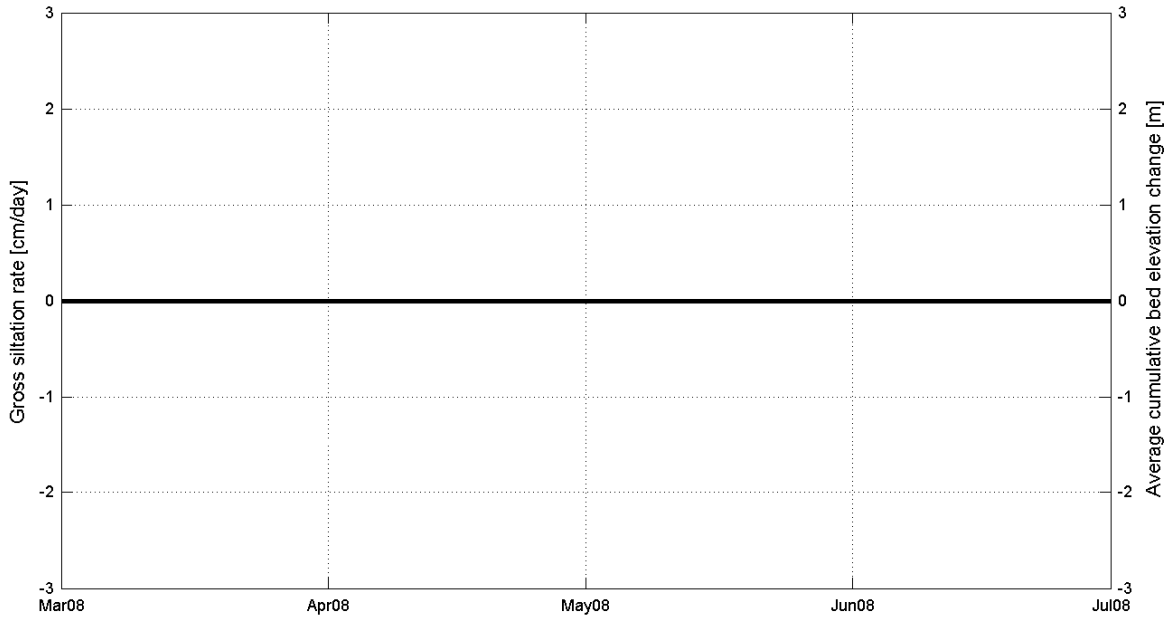
Long-term monitoring siltation Deurganckdok

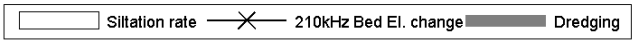
Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation over section D13
t0 = 13-Mar-2008



Gross siltation over section D14
t0 = 13-Mar-2008





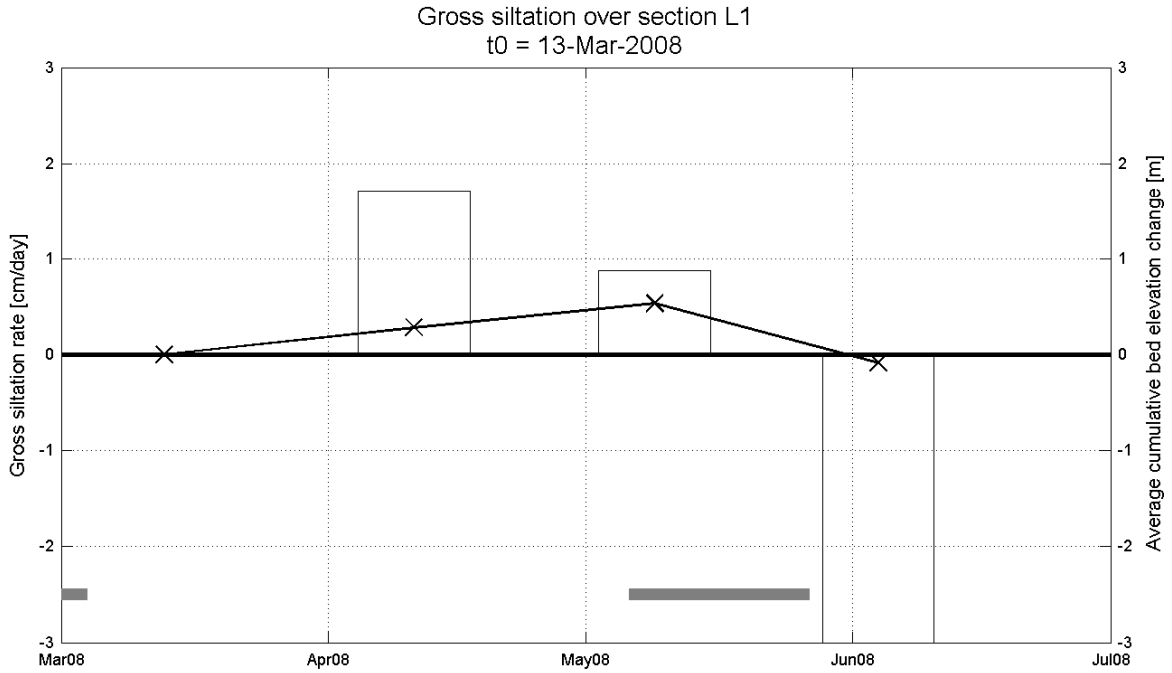
Reference level: depth sounding 13-Mar-2008

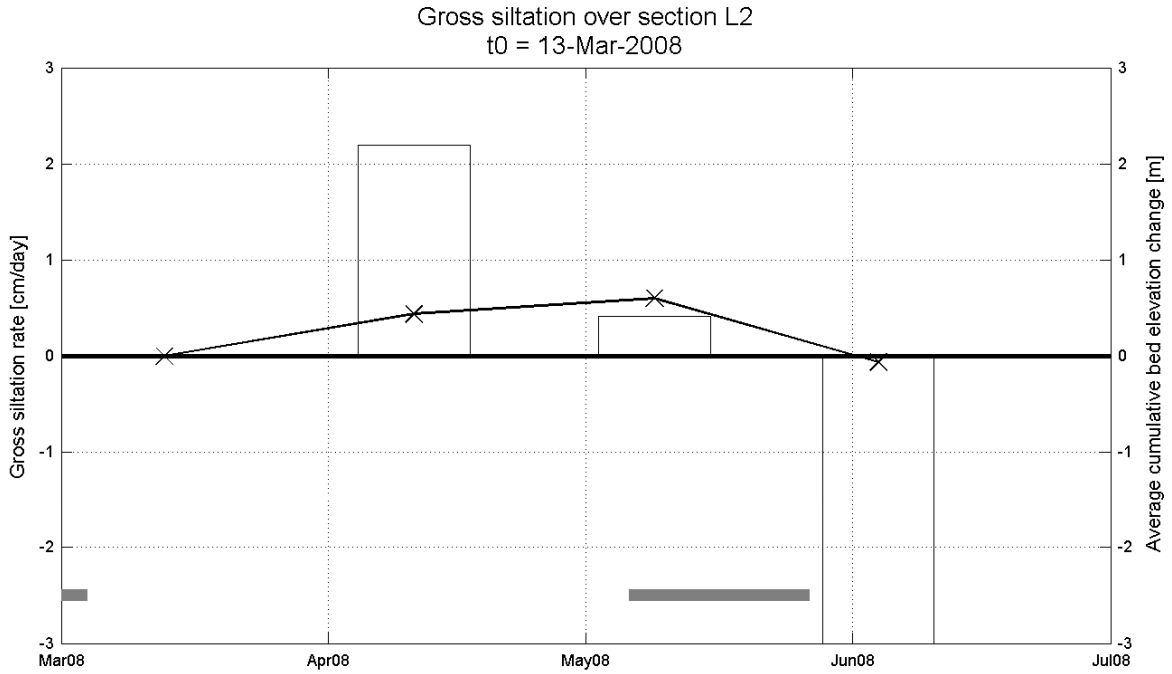
Data Processed by:
In association with :

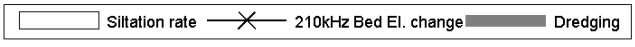
I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD







Reference level: depth sounding 13-Mar-2008

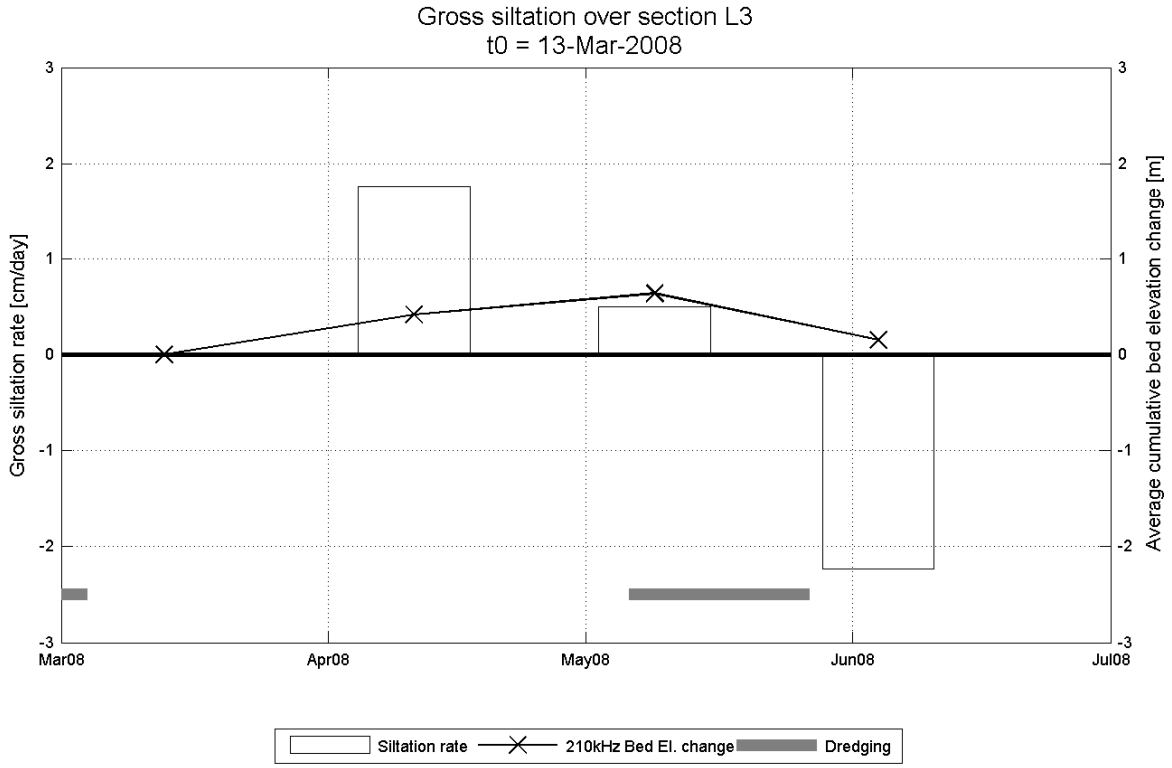
Data Processed by: IMDC

In association with : WL | delft hydraulics

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 13-Mar-2008

Data Processed by:

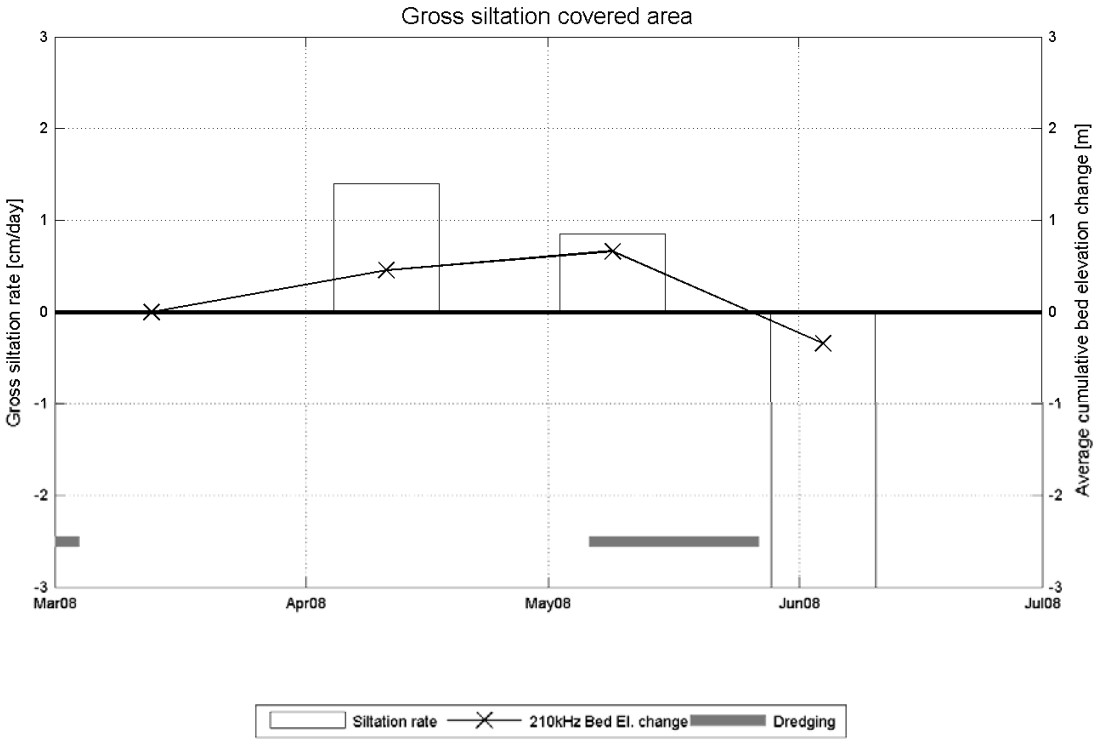
In association with :

I/RA/11283/08.076/MSA

C.4 Siltation rate complete Deurganckdok

Long-term monitoring siltation Deurganckdok

Siltation height / gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 13-Mar-2008

Data Processed by: IMDC

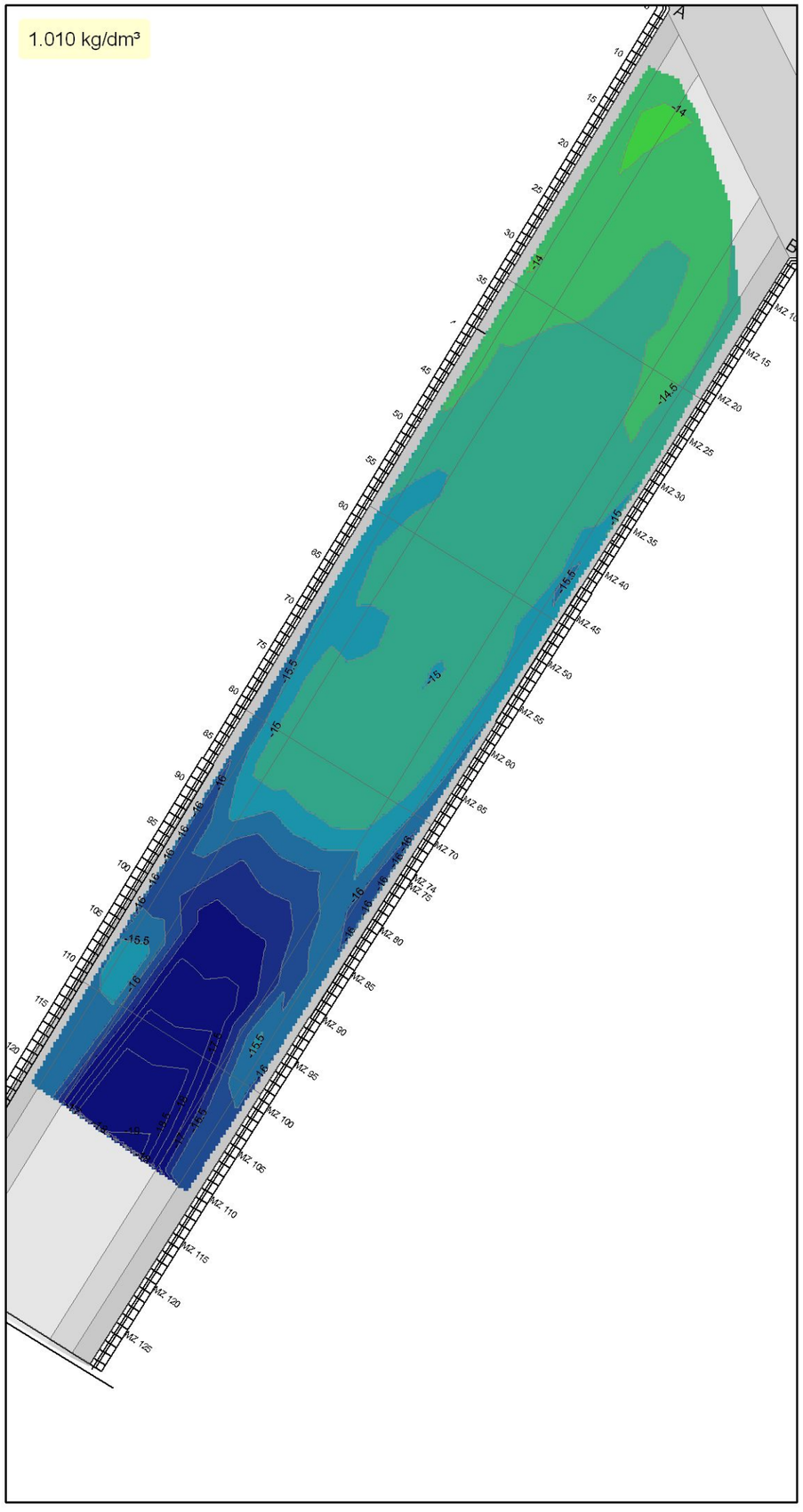
In association with : wl | delft hydraulics

I/RA/11283/08.076/MSA

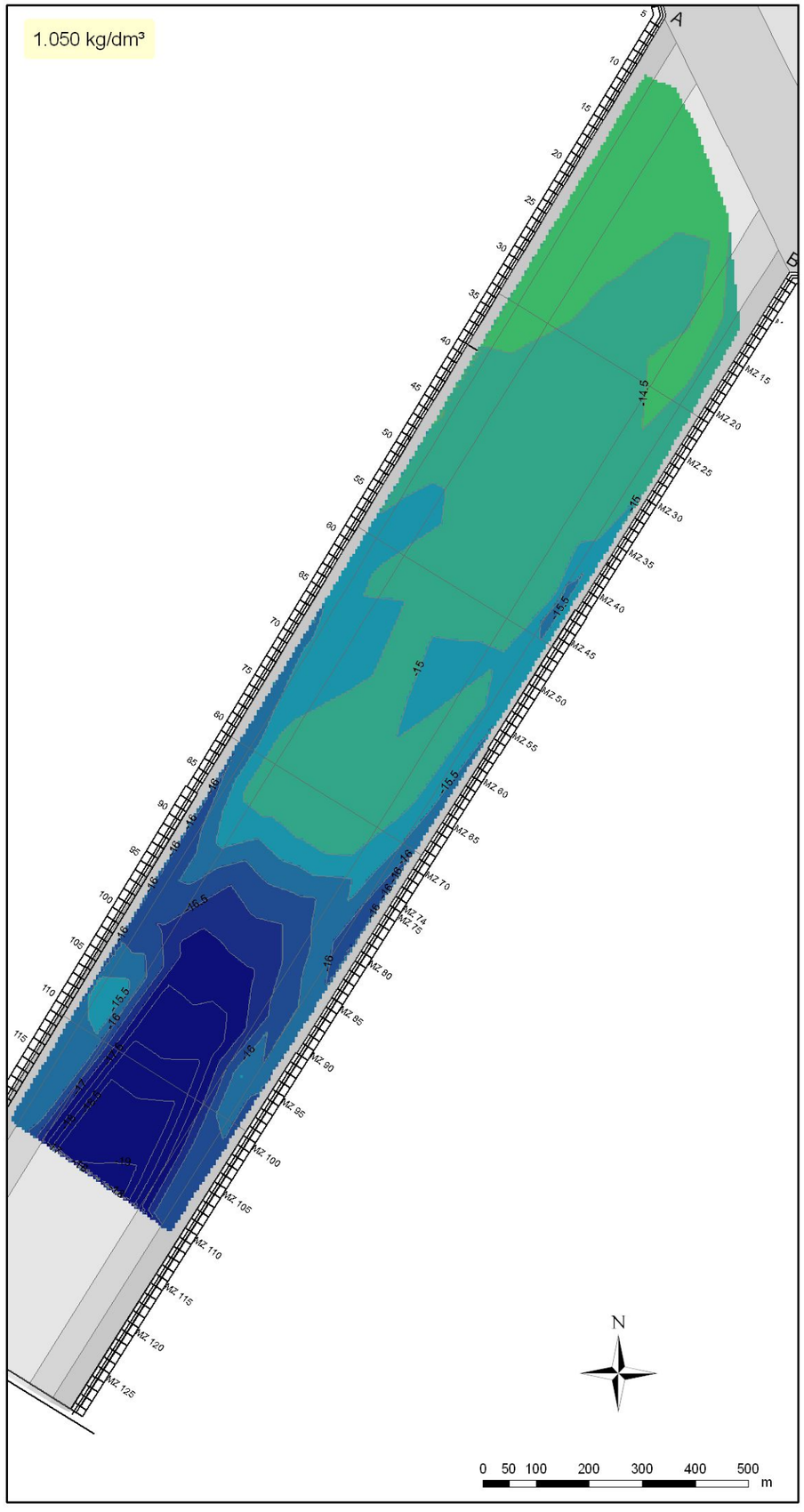
APPENDIX D.

DEPTH OF WATER-BED INTERFACE AND EQUAL DENSITY LAYERS

1.010 kg/dm³



1.050 kg/dm³



Long-term measurements
Deurganckdok
Evolution & analysis of siltation

Bestek nr 16EB/05/04

Water-bed interface & equal density layer

28 april 2008 (measurement 07)

Map 1 Scalel 1/10.000

Created: 29/08/2008 I/DR/11283/08.000/JUR

Version nr. 1

IMDC
Wilrijkstraat 37
2140 Antwerpen
Tel:+32.3.2709295
Fax:+32.3.2356711
E-mail: info@imdc.be

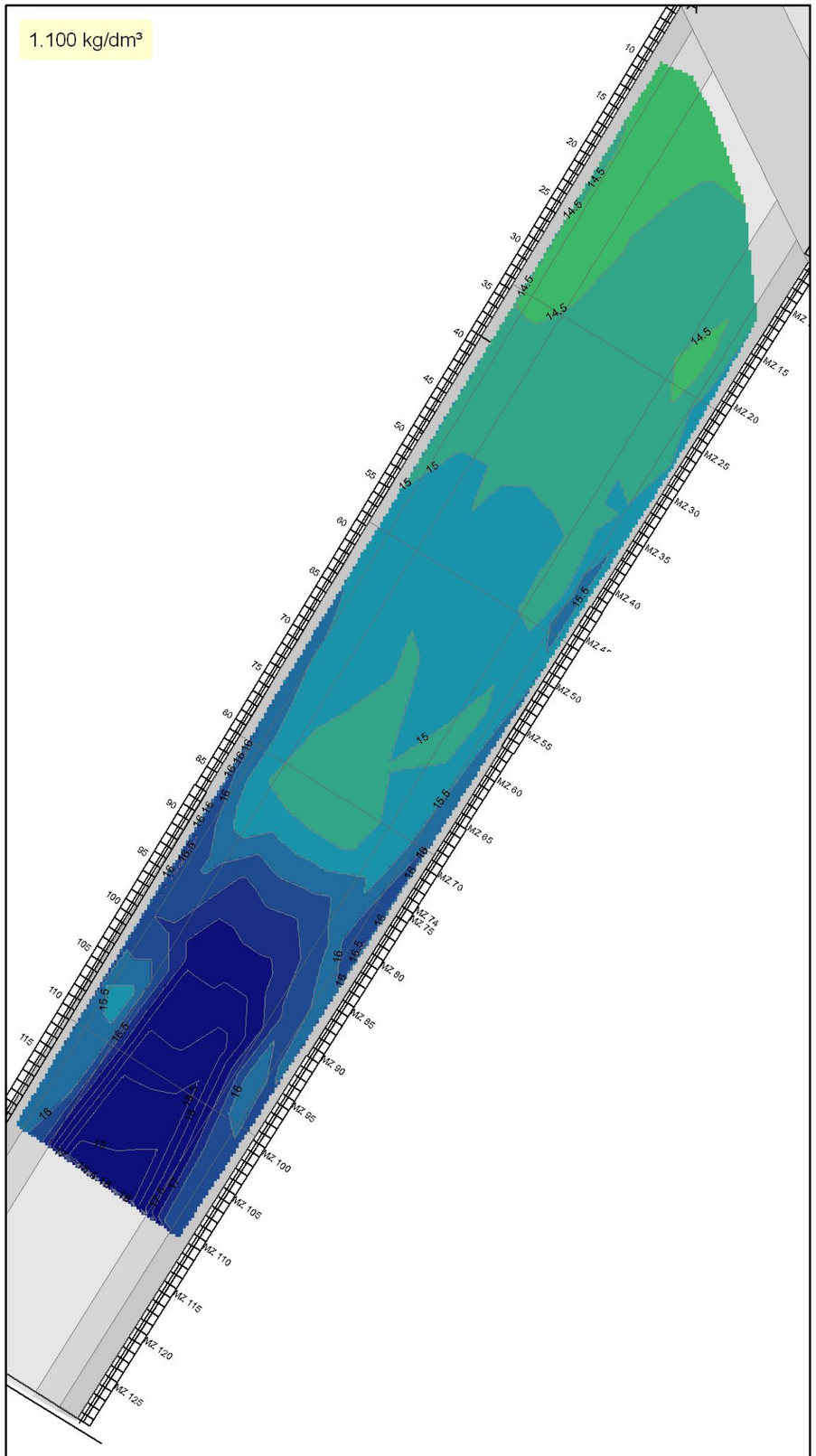
Legend

Elevation of equal density layers (m TAW)

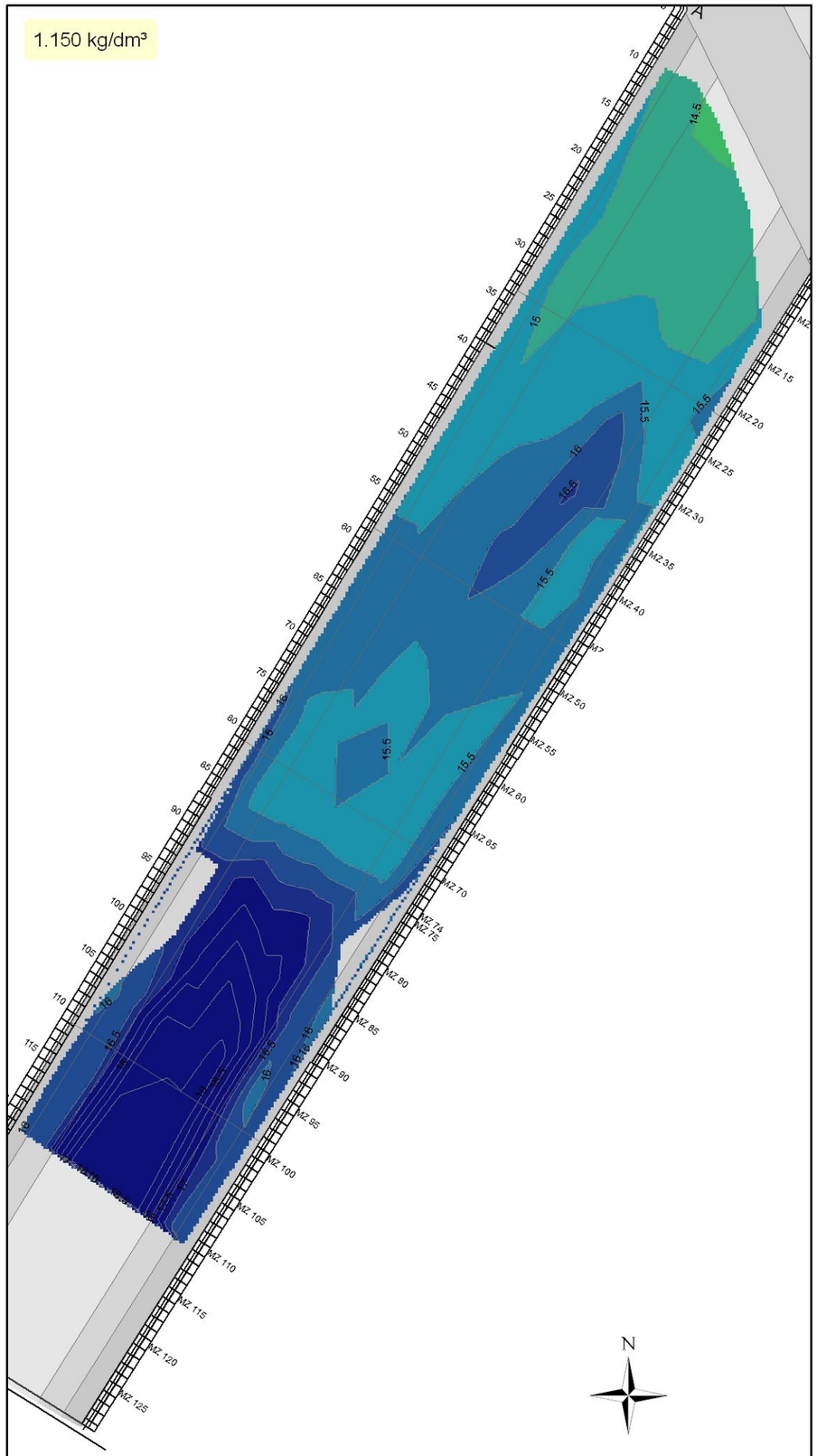
- -11.00 - -11.50
- -11.51 - -12.00
- -12.01 - -12.50
- -12.51 - -13.00
- -13.01 - -13.50
- -13.51 - -14.00
- -14.01 - -14.50
- -14.51 - -15.00
- -15.01 - -15.50
- -15.51 - -16.00
- -16.01 - -16.50
- -16.51 - -17.00
- -17.01 - -17.50

File: W:\11283\GIS\project\rapport 1-20\EDL\Measurement-07\DGD07_K1_1010-1050.mxd

1.100 kg/dm³



1.150 kg/dm³



Long-term measurements Deurganckdok Evolution & analysis of siltation

Bestek nr 16EB/05/04

Water-bed interface & equal density layer

28 april 2008 (measurement 07)

Map 2 — Scalel 1/10.000

Created: 29/08/2008 — I/DR/11283/08.000/JUR

Version nr. 1

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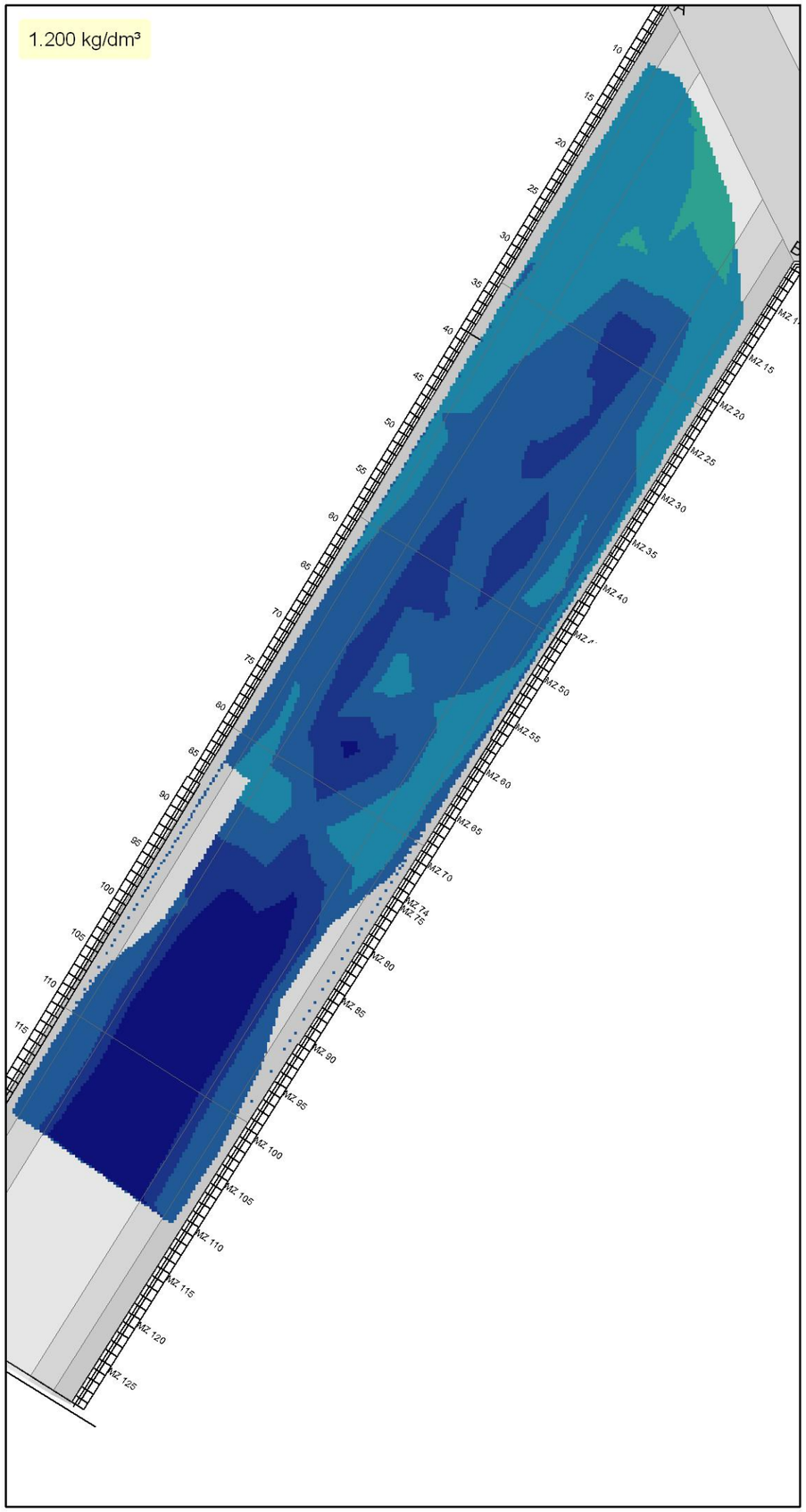
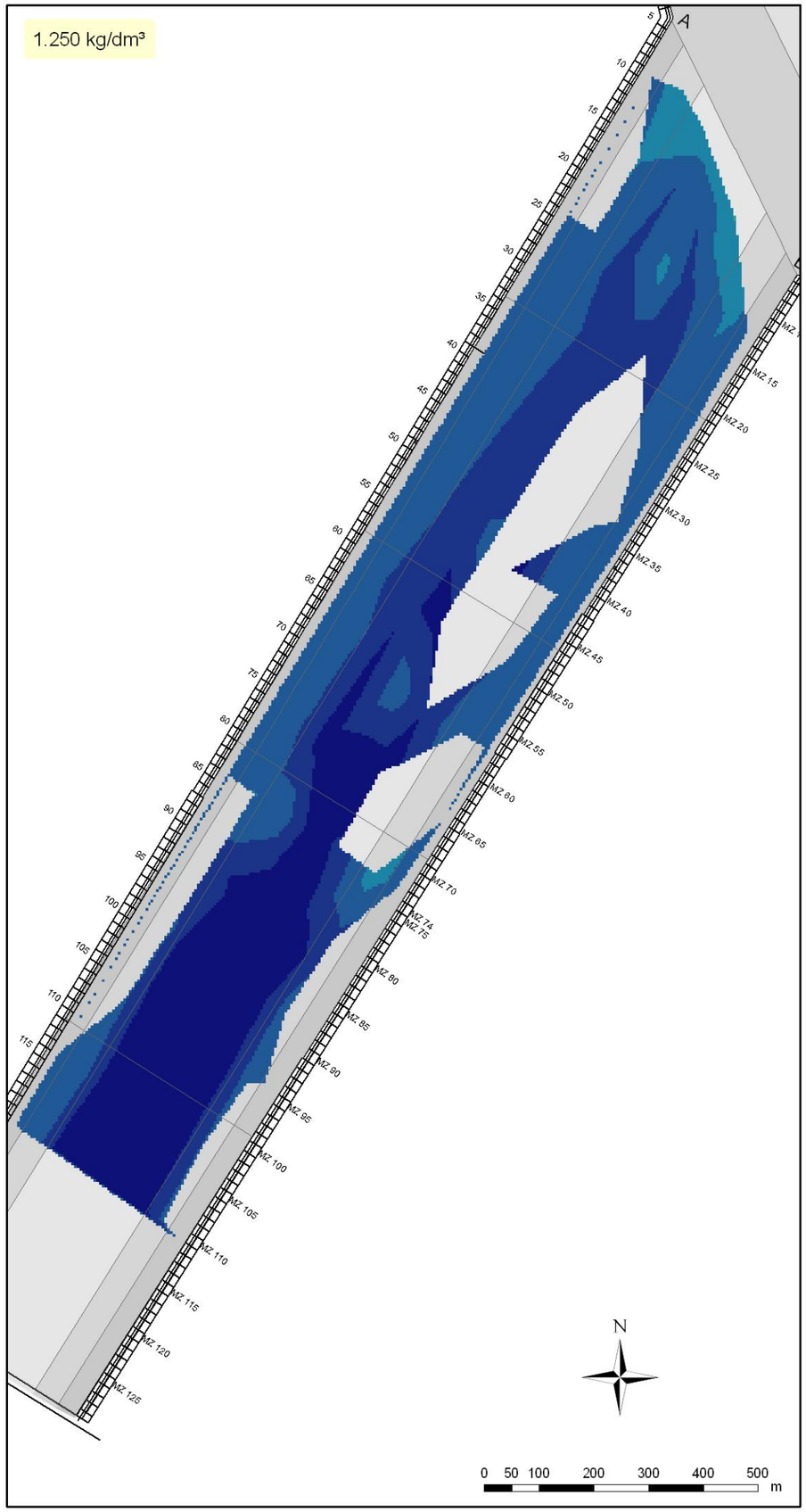
Legend

Elevation of equal density layers (m TAW)

- -11.00 - -11.50
- -11.51 - -12.00
- -12.01 - -12.50
- -12.51 - -13.00
- -13.01 - -13.50
- -13.51 - -14.00
- -14.01 - -14.50
- -14.51 - -15.00
- -15.01 - -15.50
- -15.51 - -16.00
- -16.01 - -16.50
- -16.51 - -17.00
- -17.01 - -17.50

File: W:\11283\GIS\project\rapport 1-20\EDL\Measurement-07\DGD07_K2_1100-1150.mxd





Long-term measurements Deurganckdok Evolution & analysis of siltation

Bestek nr 16EB/05/04

Water-bed interface & equal density layer

28 april 2008 (measurement 07)

Map 3 — Scalel 1/10.000

Created: 29/08/2008 — I/DR/11283/08.000/JUR

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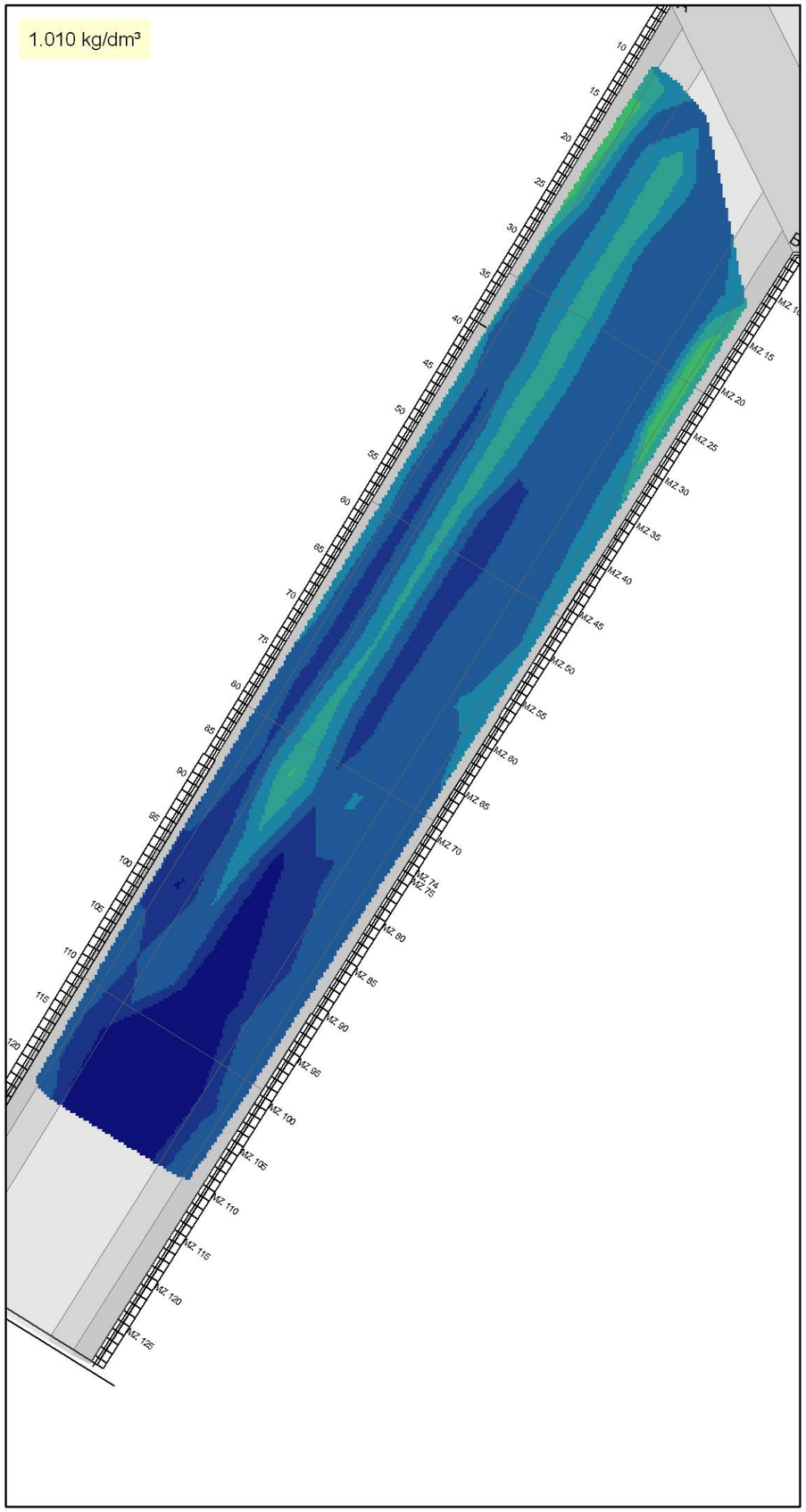
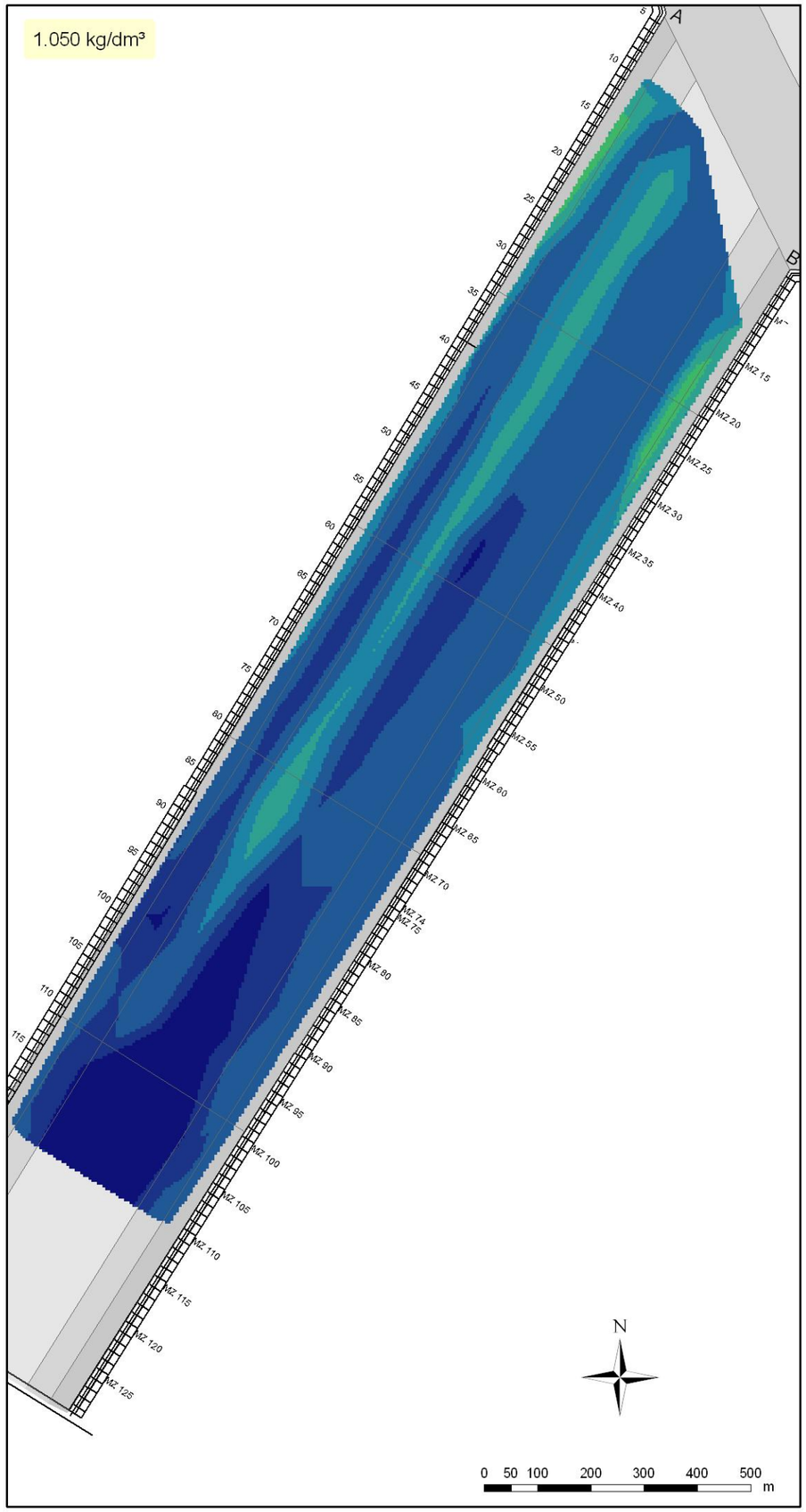
Fax:+32.3.2356711
E-mail: info@imdc.be

Legend

Elevation of equal density layers (m TAW)

-8.99 -	-8.00
-9.99 -	-9.00
-10.99 -	-10.00
-11.99 -	-11.00
-12.99 -	-12.00
-13.99 -	-13.00
-14.99 -	-14.00
-15.99 -	-15.00
-16.99 -	-16.00
-17.99 -	-17.00
-19.00 -	-18.00





Long-term measurements Deurganckdok Evolution & analysis of siltation

Bestek nr 16EB/05/04

Water-bed interface & equal density layer

05 june 2008 (measurement 08)

Map 1 Scalel 1/10.000

Created: 29/08/2008 I/DR/11283/08.000/JUR

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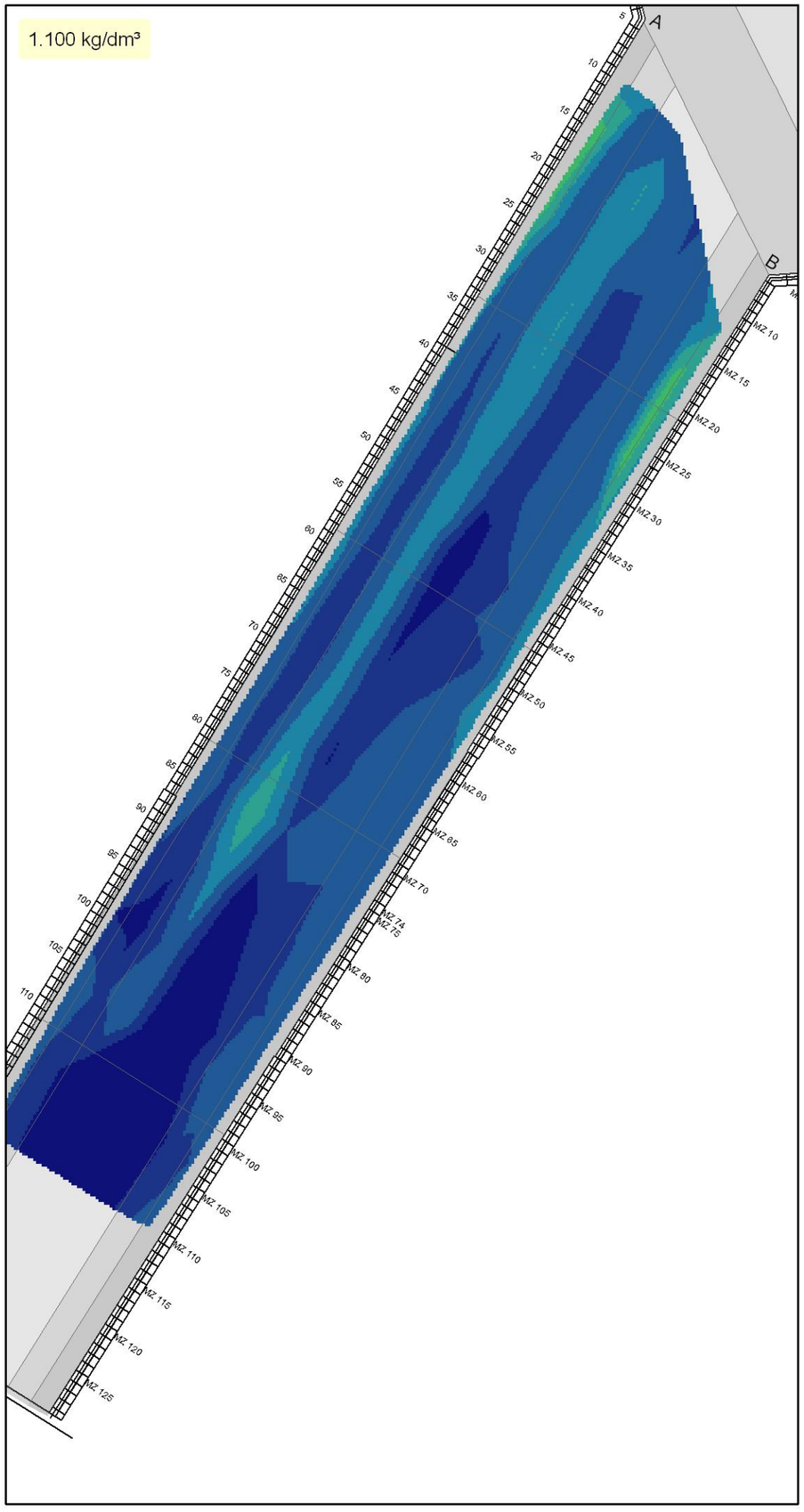
Legend

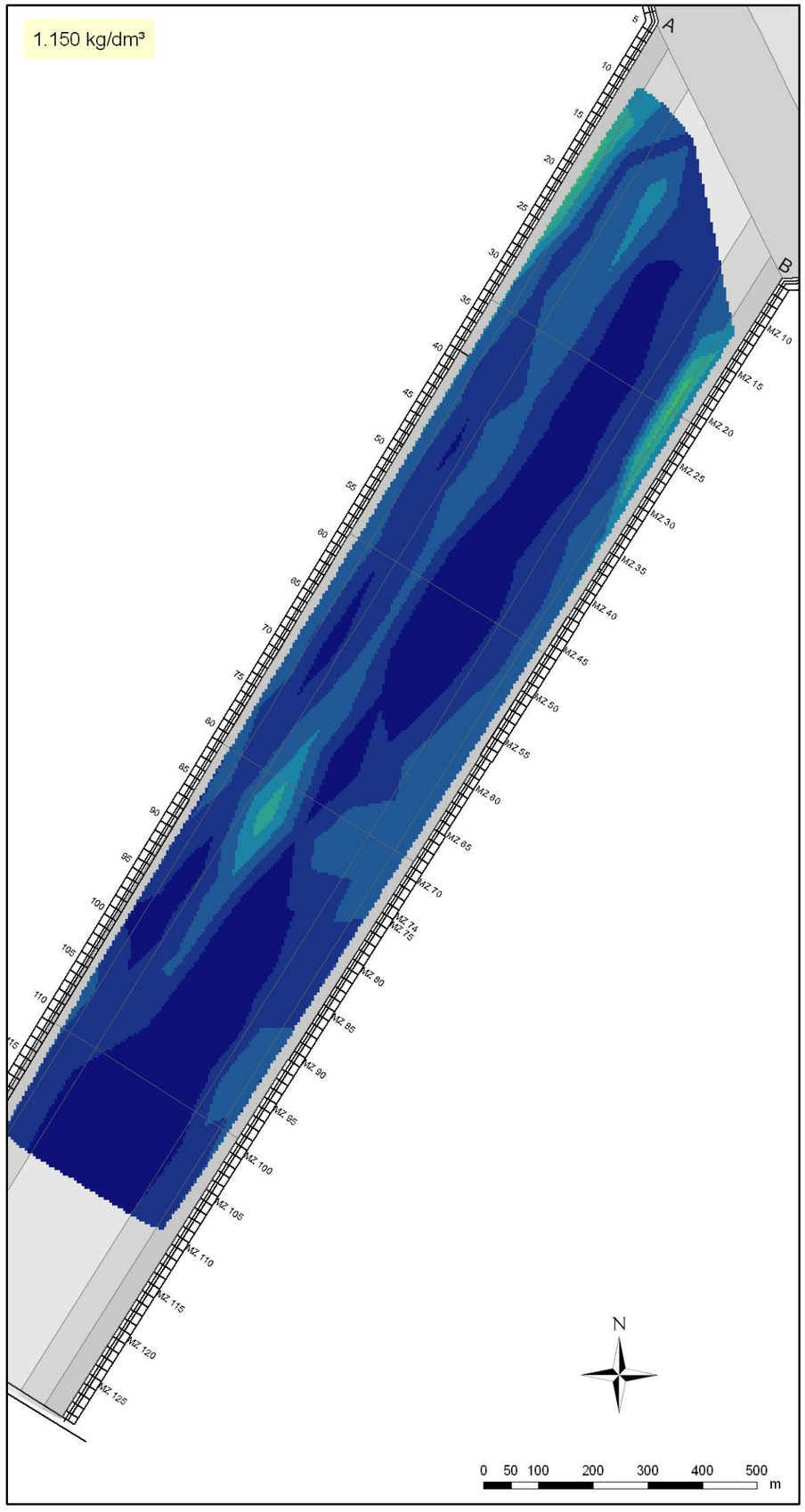
Elevation of equal density layers (m TAW)

-8.99 -	-8.00
-9.99 -	-9.00
-10.99 -	-10.00
-11.99 -	-11.00
-12.99 -	-12.00
-13.99 -	-13.00
-14.99 -	-14.00
-15.99 -	-15.00
-16.99 -	-16.00
-17.99 -	-17.00
-19.00 -	-18.00

1.100 kg/dm³



1.150 kg/dm³



Long-term measurements
Deurganckdok
Evolution & analysis of siltation

Bestek nr 16EB/05/04

Water-bed interface & equal density layer

05 june 2008 (measurement 08)

Map 2 Scalel 1/10.000

Created: 29/08/2008 I/DR/11283/08.000/JUR

Version nr. 1

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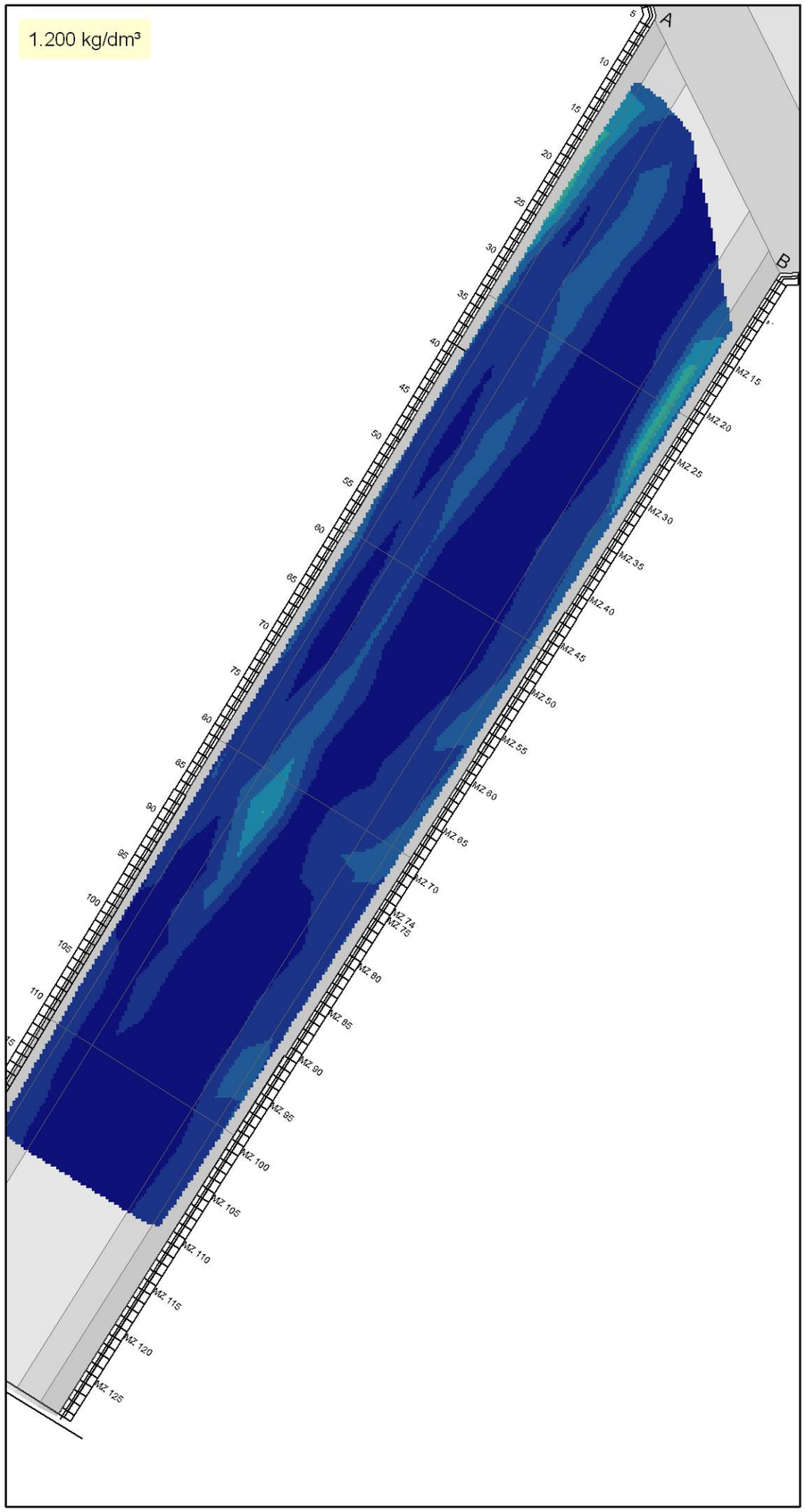
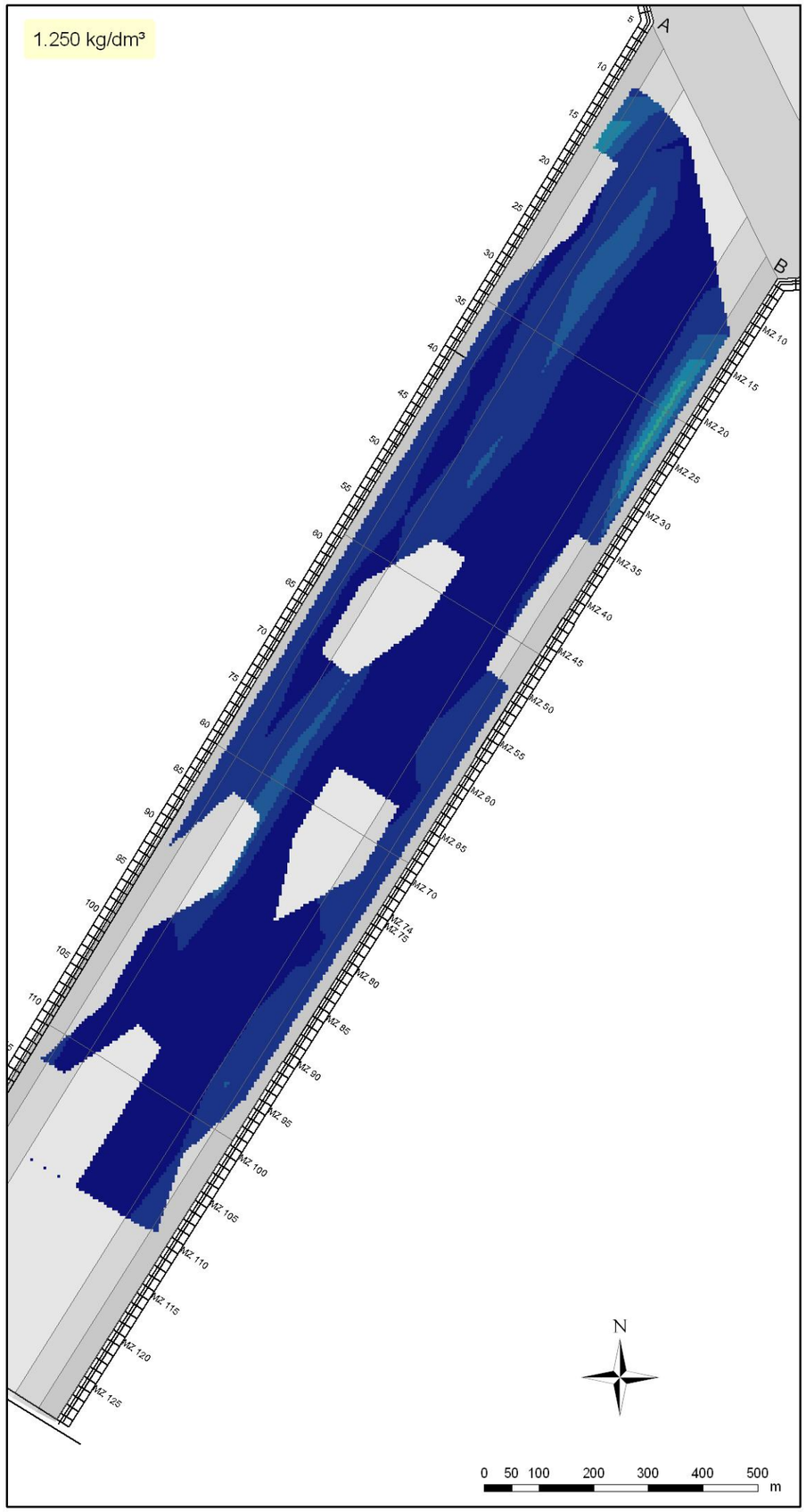
Legend

Elevation of equal density layers (m TAW)

-8.99 -	-8.00
-9.99 -	-9.00
-10.99 -	-10.00
-11.99 -	-11.00
-12.99 -	-12.00
-13.99 -	-13.00
-14.99 -	-14.00
-15.99 -	-15.00
-16.99 -	-16.00
-17.99 -	-17.00
-19.00 -	-18.00





Long-term measurements Deurganckdok Evolution & analysis of siltation

Bestek nr 16EB/05/04

Water-bed interface & equal density layer

05 june 2008 (measurement 08)

Map 3 — Scalel 1/10.000

Created: 29/08/2008 — I/DR/11283/08.000/JUR

Version nr. 1

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Legend

Elevation of equal density layers (m TAW)

-8.99 -	-8.00
-9.99 -	-9.00
-10.99 -	-10.00
-11.99 -	-11.00
-12.99 -	-12.00
-13.99 -	-13.00
-14.99 -	-14.00
-15.99 -	-15.00
-16.99 -	-16.00
-17.99 -	-17.00
-19.00 -	-18.00

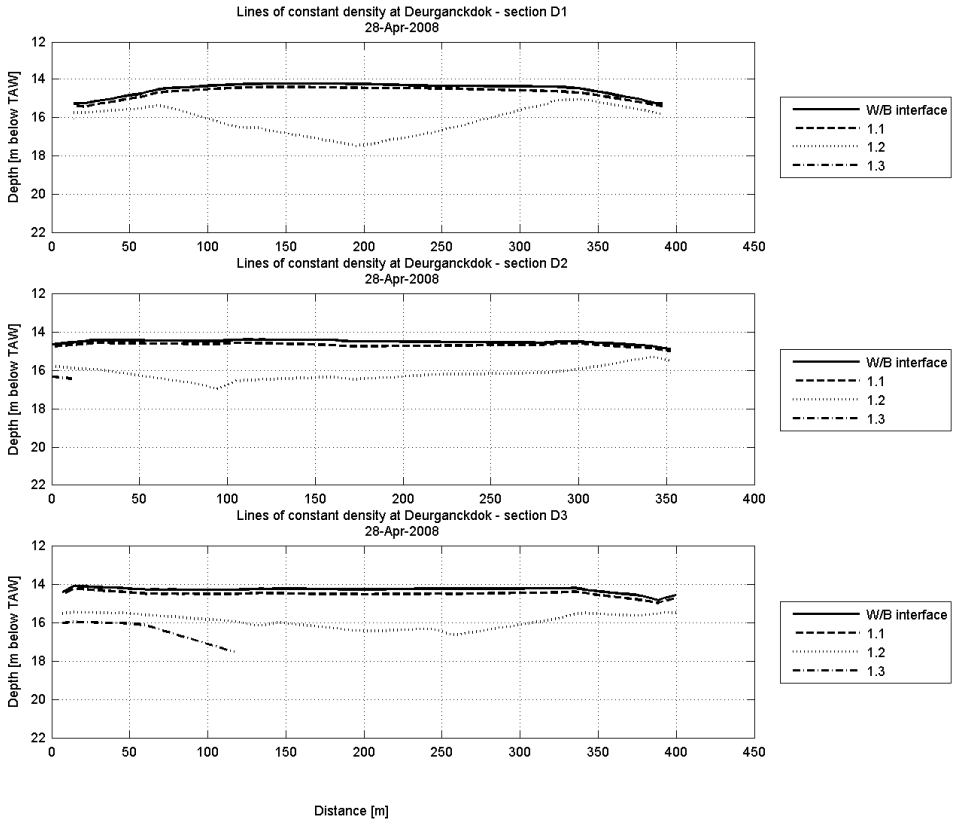
APPENDIX E.

DEPTH OF PLANES OF CONSTANT DENSITY

E.1 Measurements April 28th, 2008

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



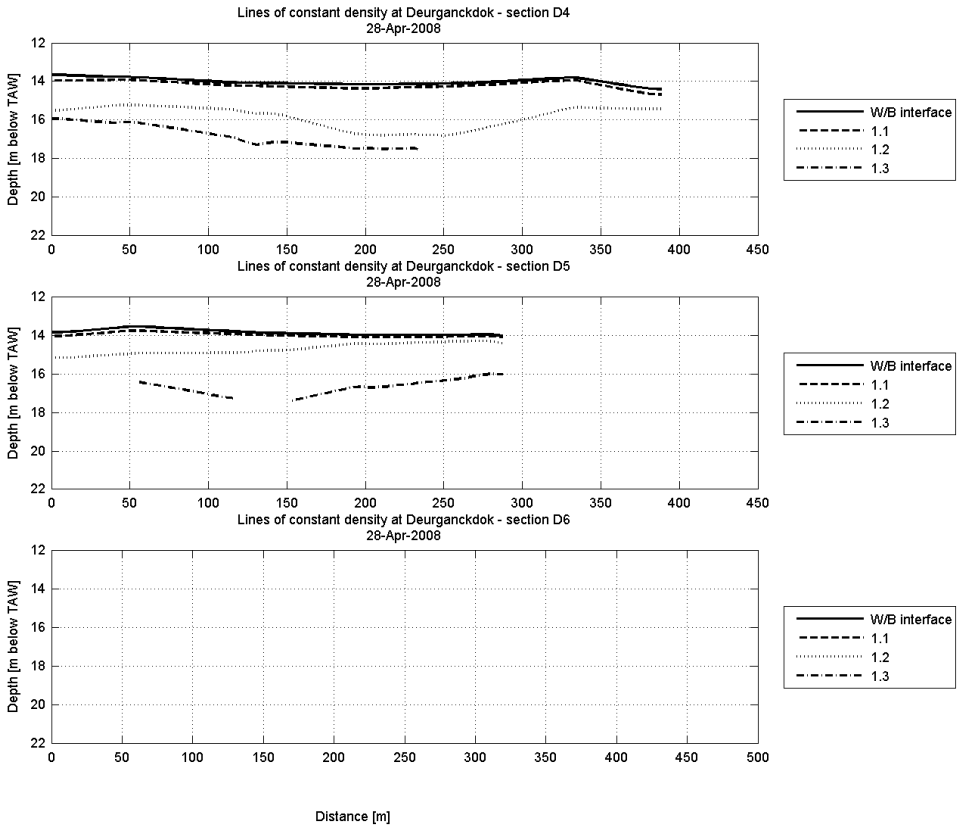
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



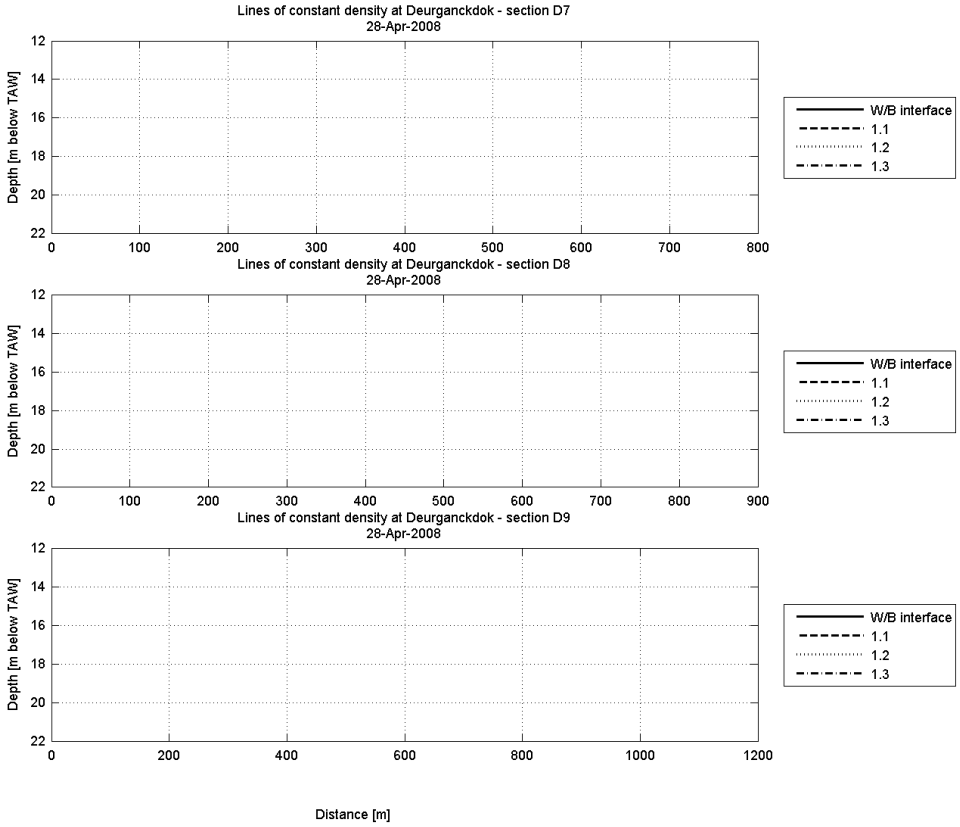
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



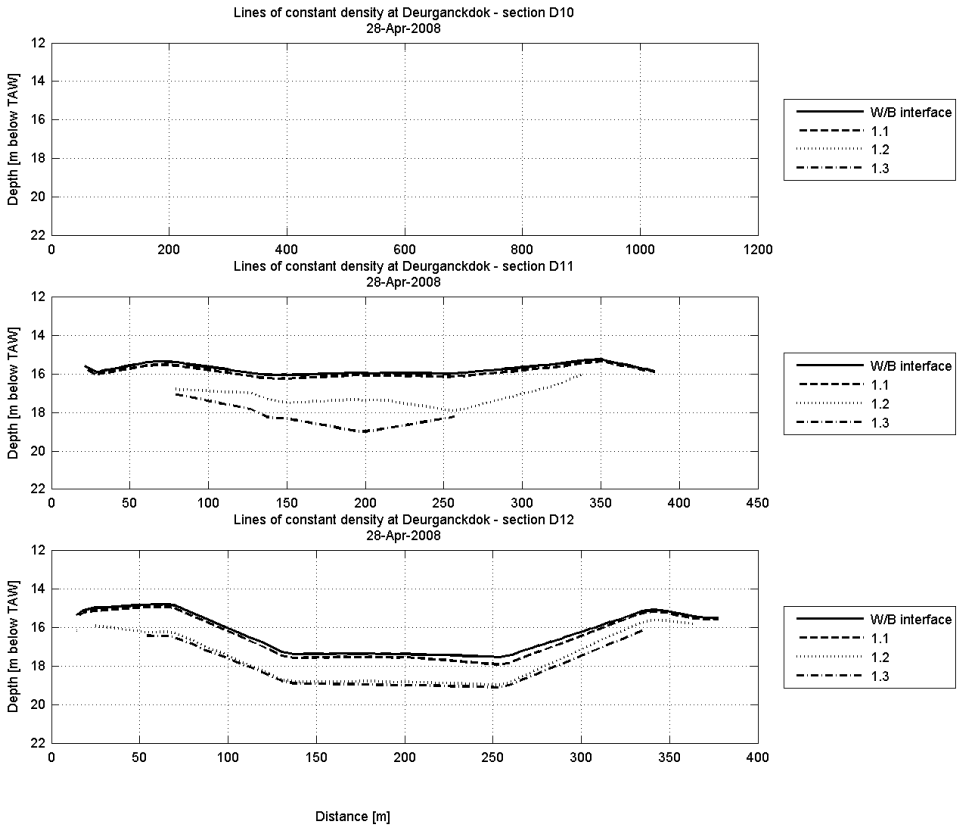
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



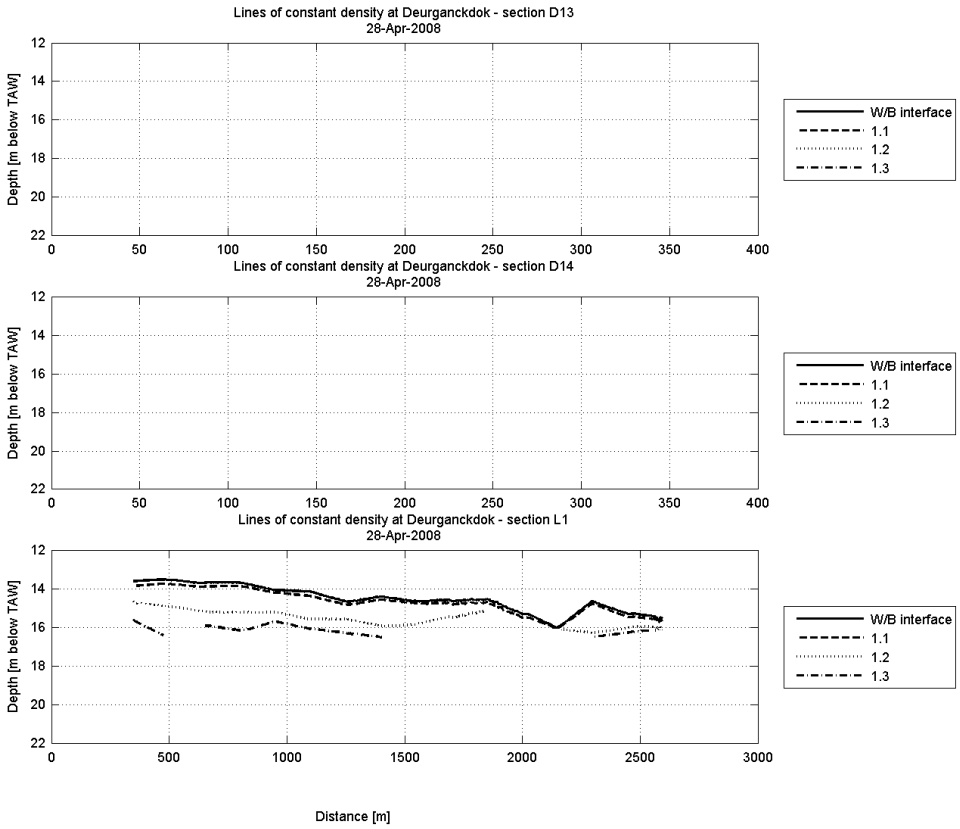
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



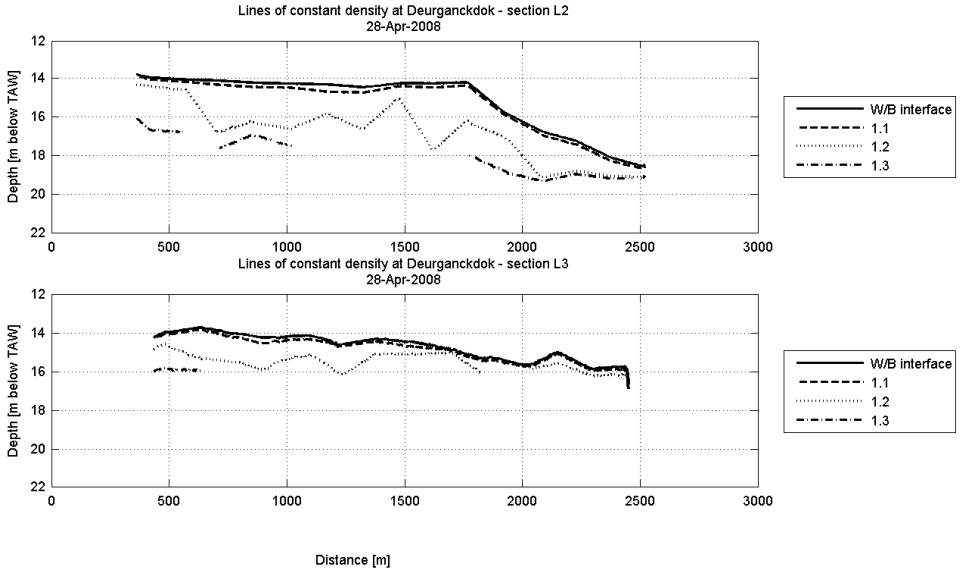
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



Data Processed by:

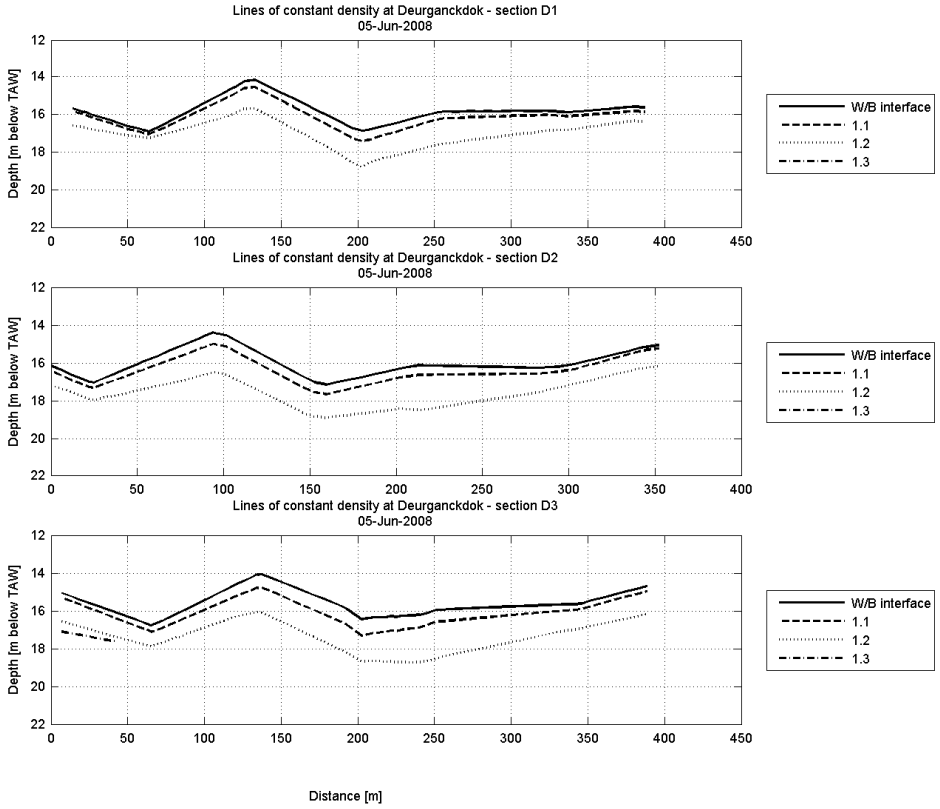
In association with :

I/RA/11283/08.076/MSA

E.2 Measurements June 5th, 2008

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



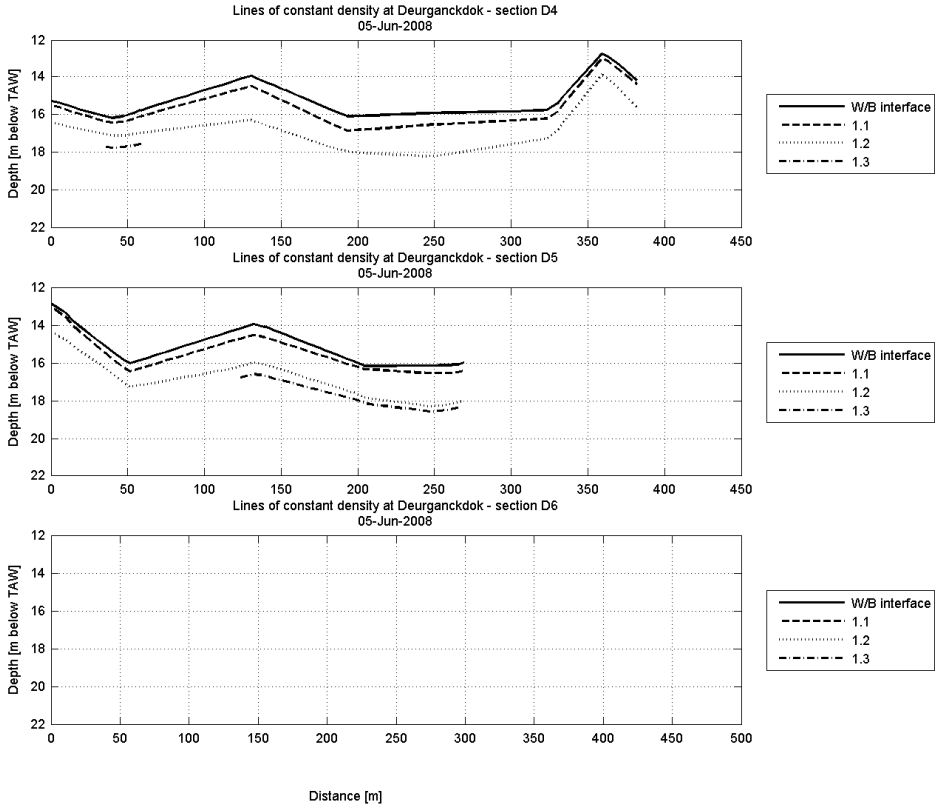
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



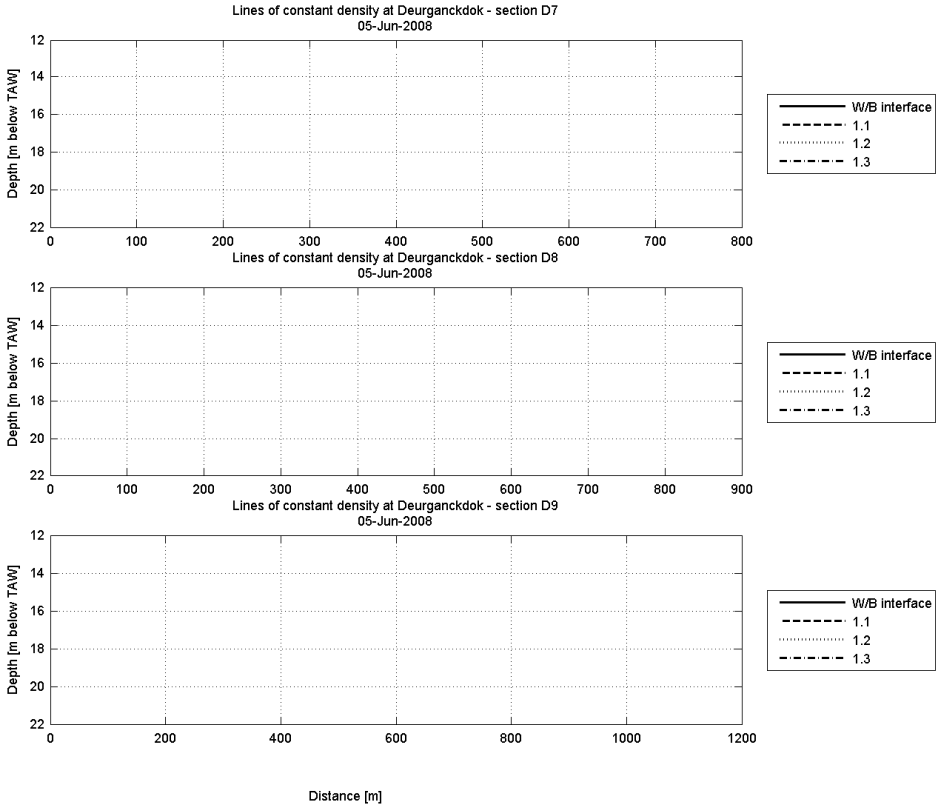
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



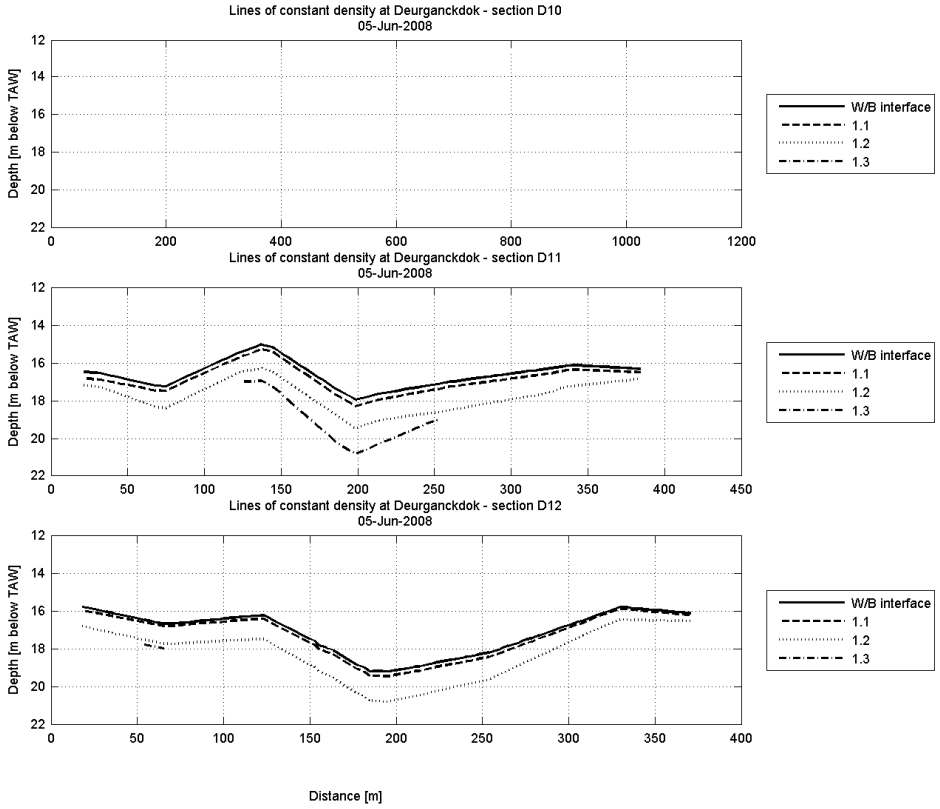
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



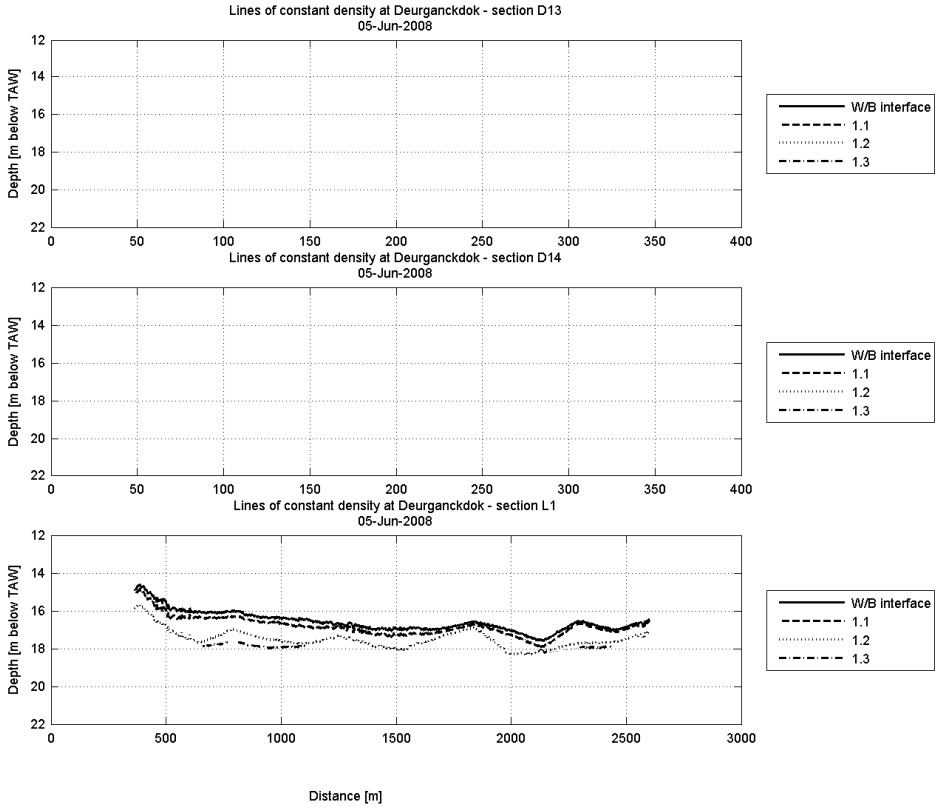
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



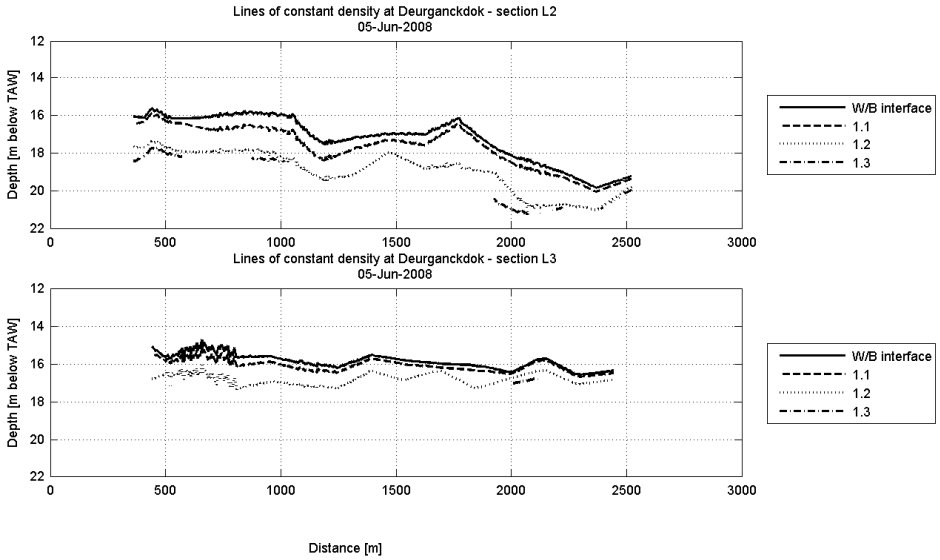
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Cross sections planes constant density	Equipment(s): NaviTracker
	Location: DGD



Data Processed by:

In association with :

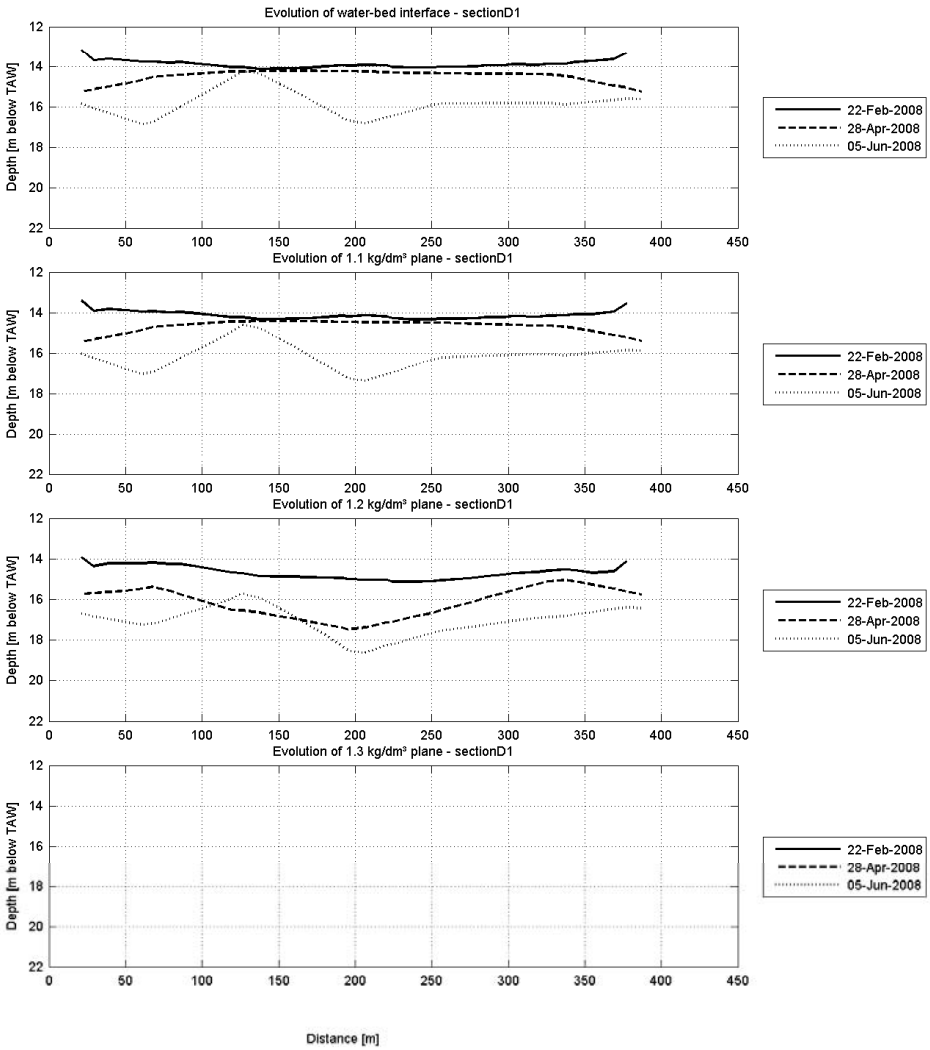
I/RA/11283/08.076/MSA

APPENDIX F.

DEPTH EVOLUTION OF PLANES OF CONSTANT DENSITY

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

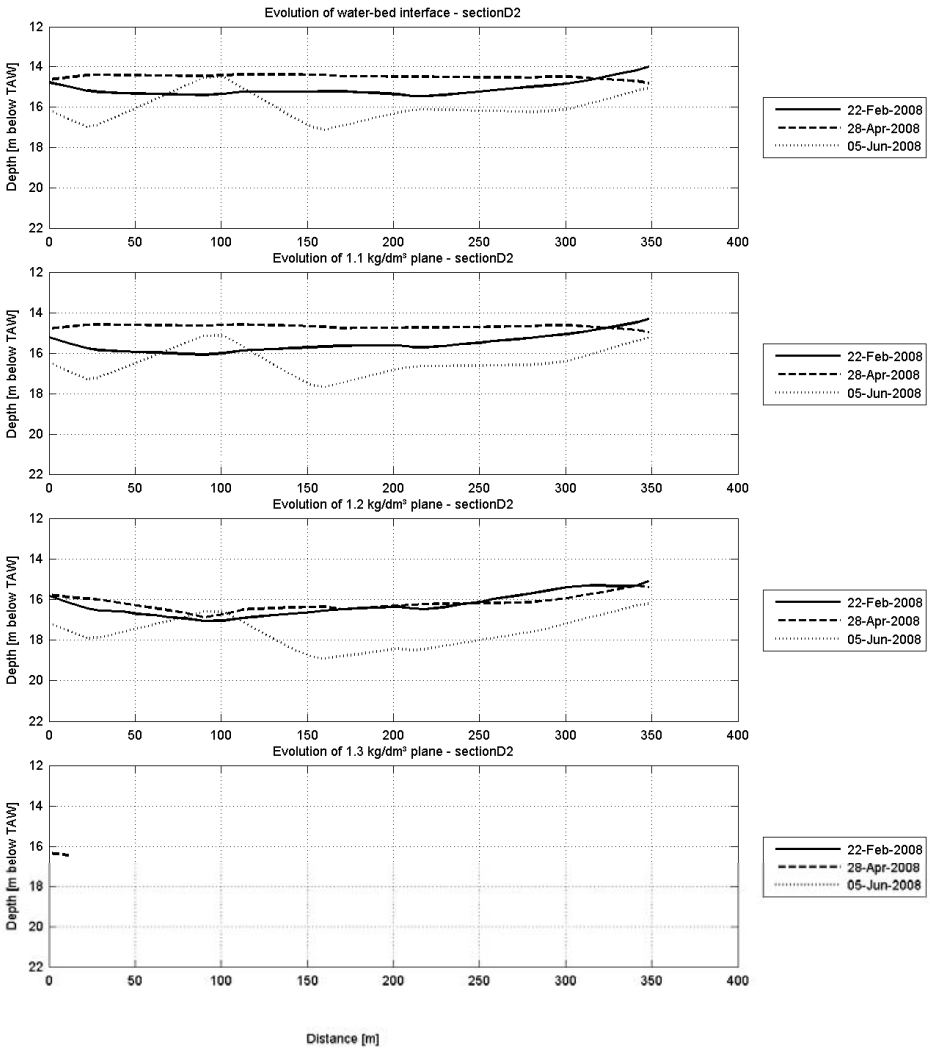


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

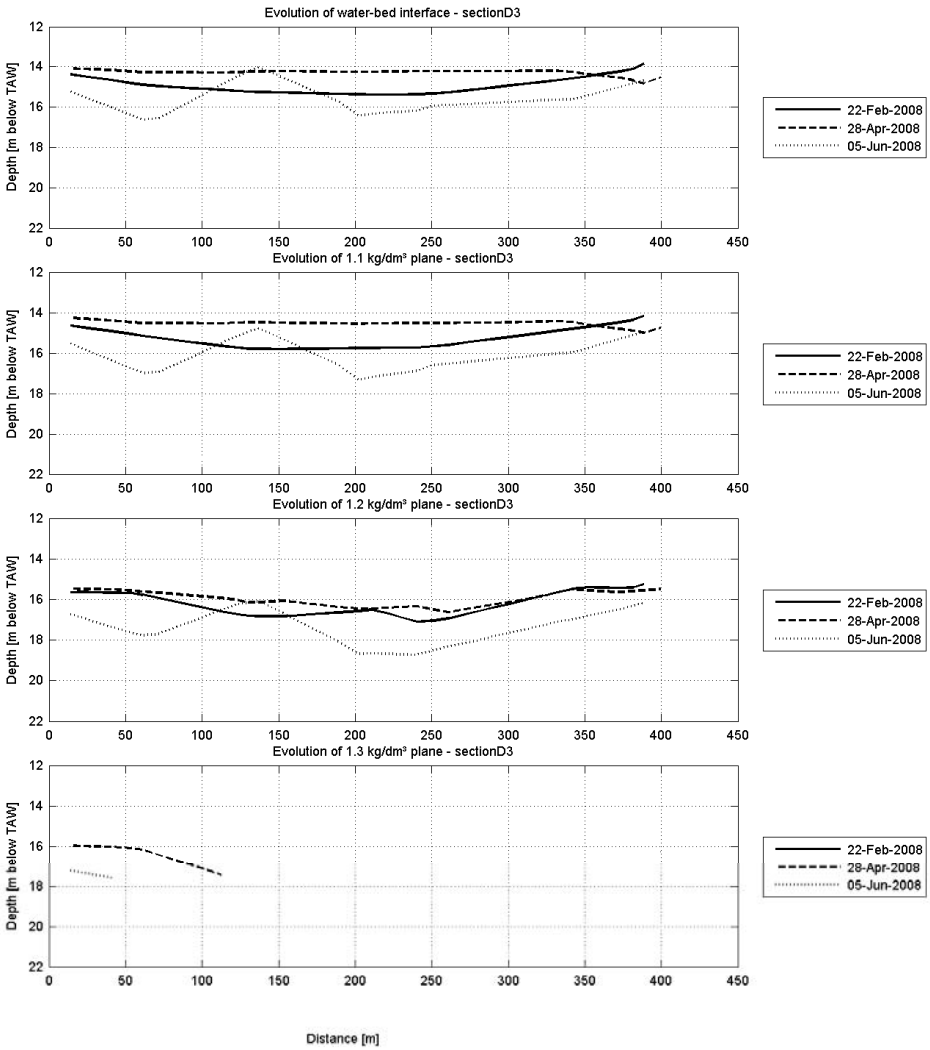


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

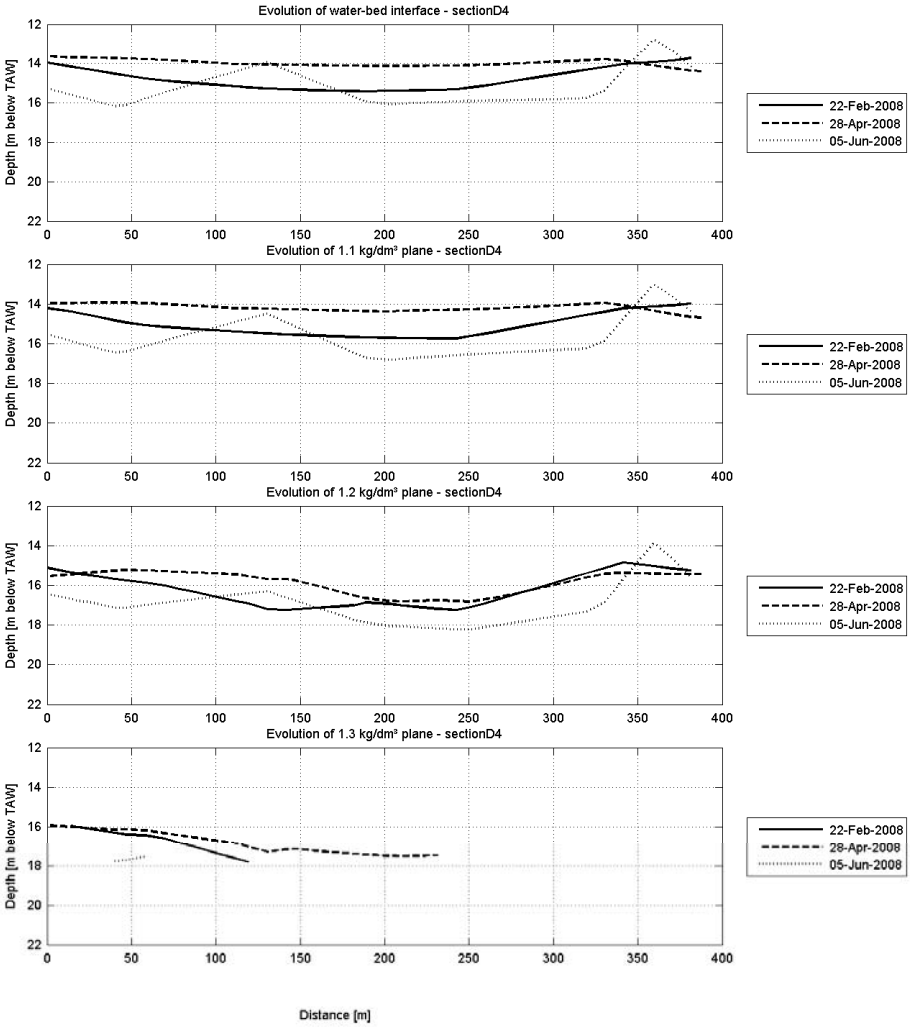


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

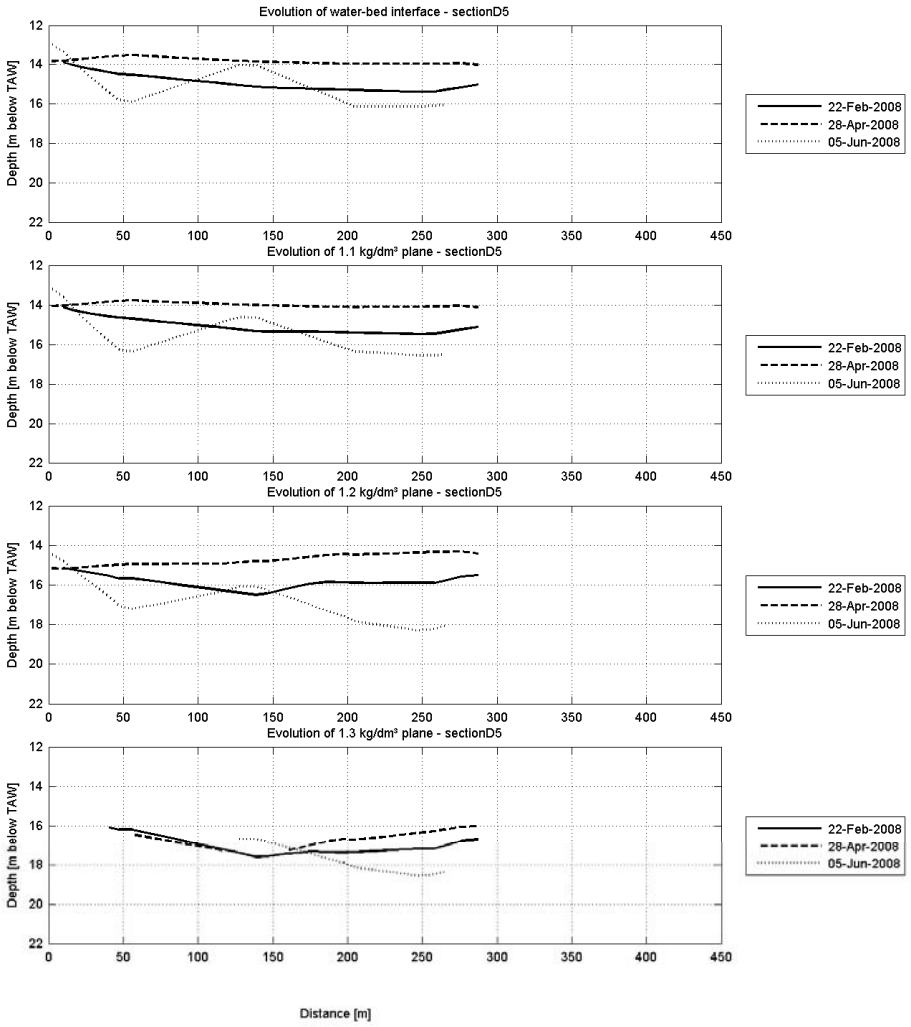


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

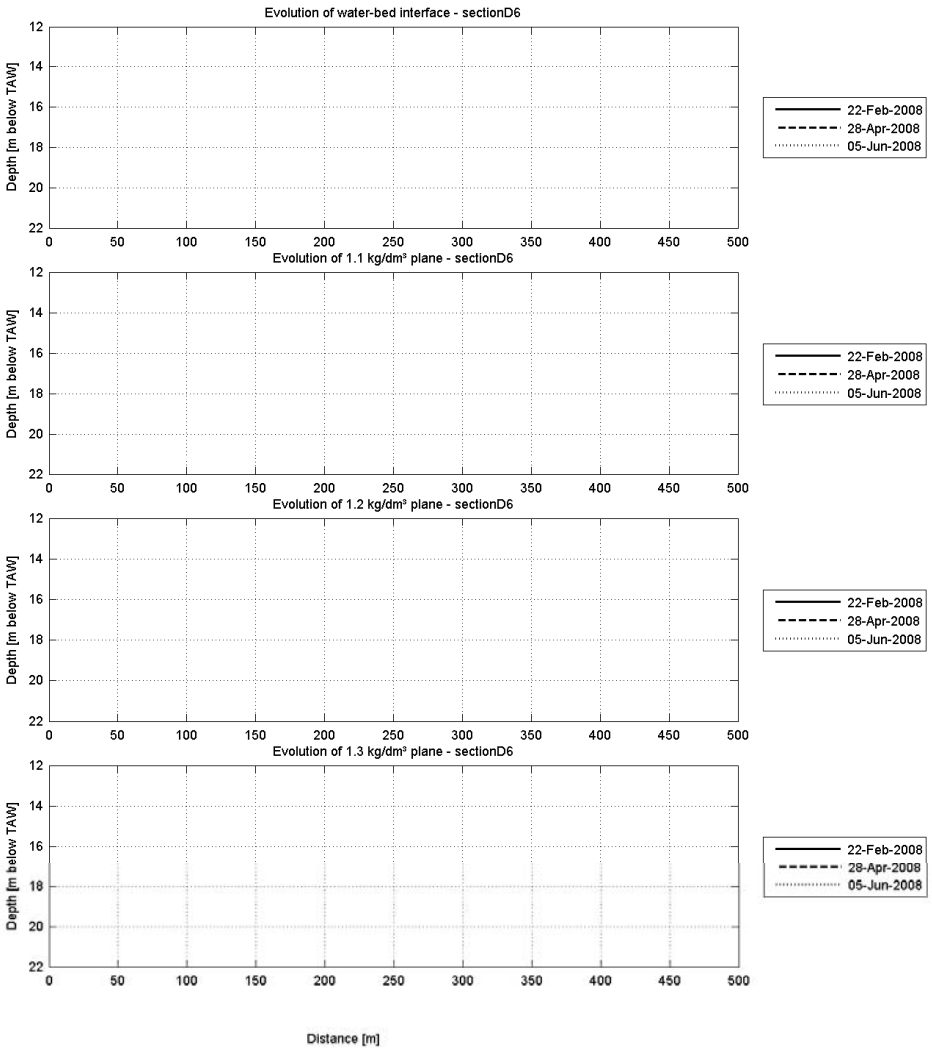


Data Processed by: IMDC
In association with : WL | Delft Hydraulics, GEMS International

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

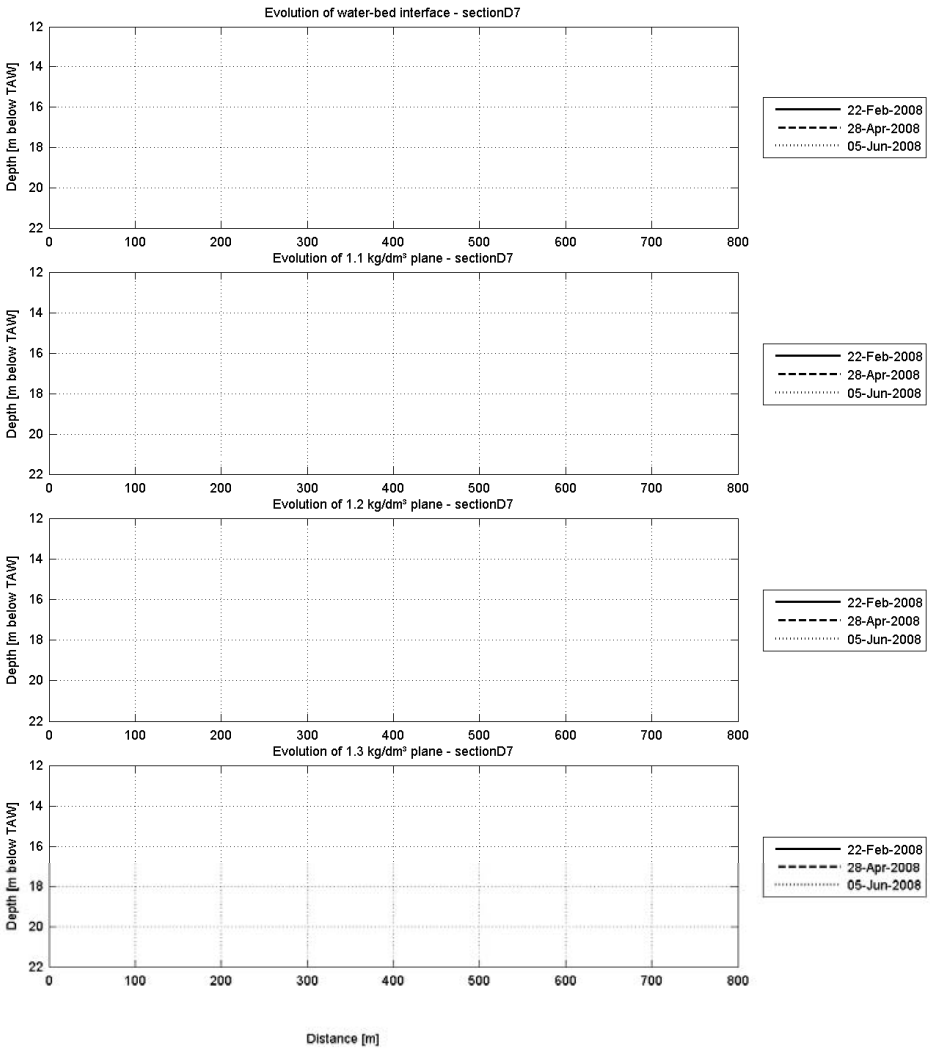


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

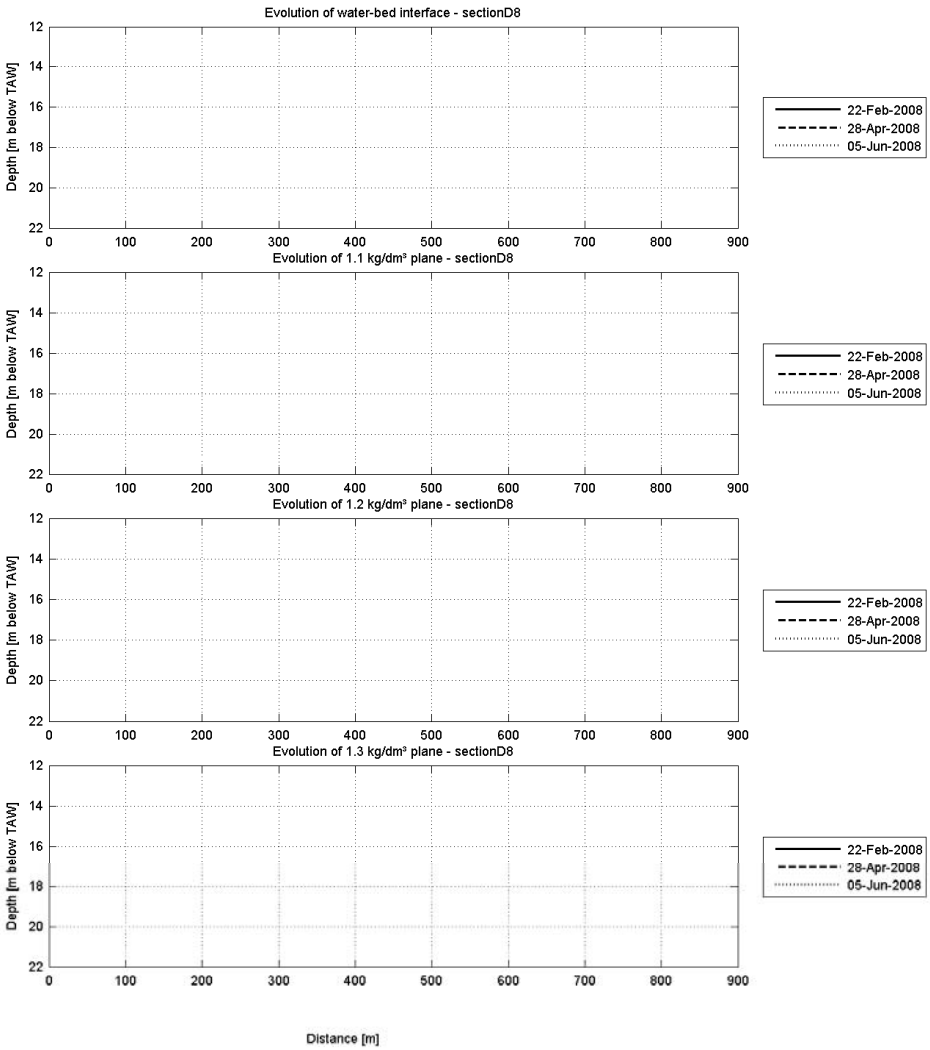


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

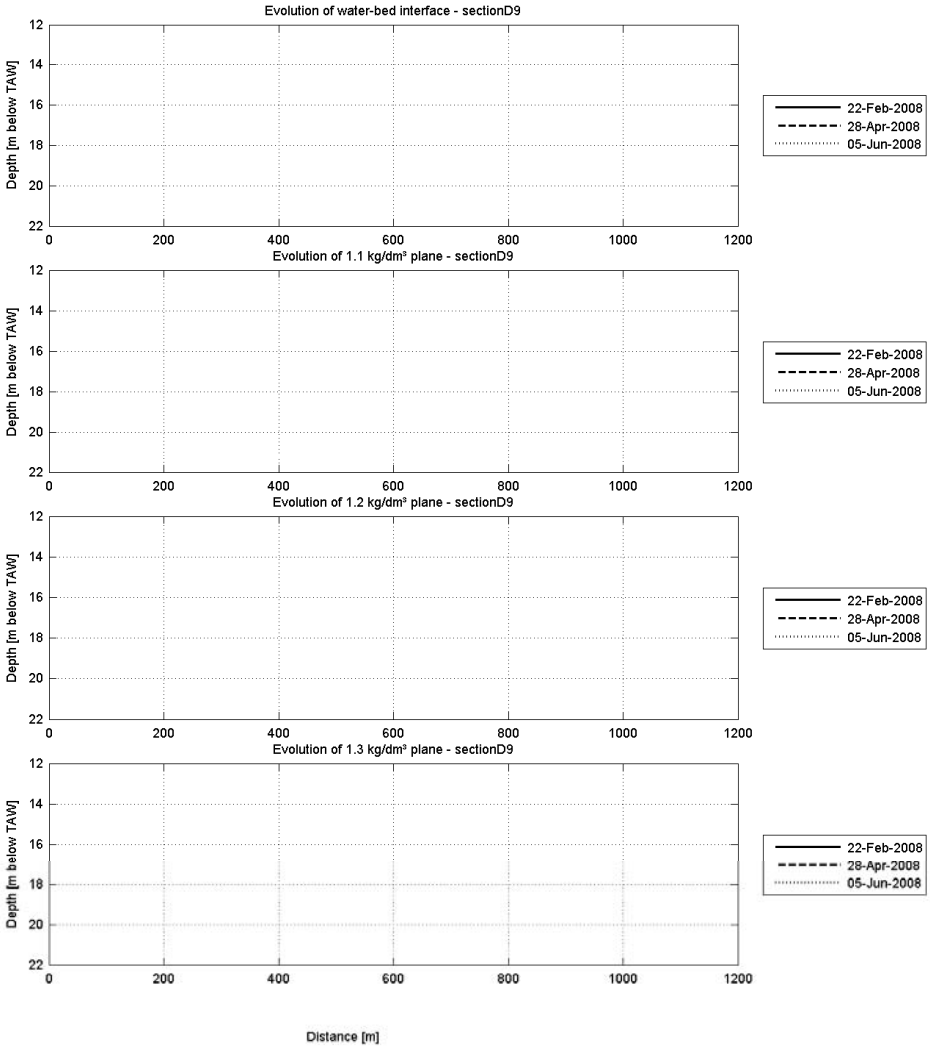


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

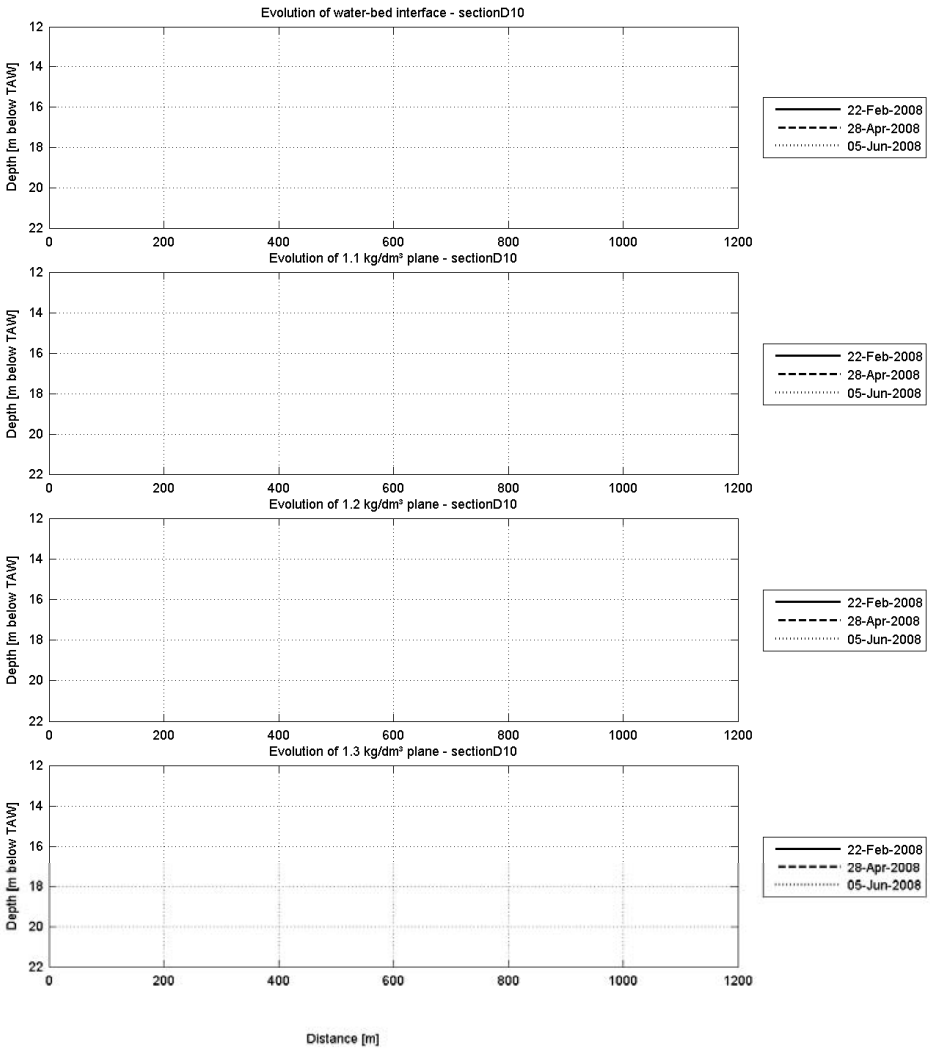


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

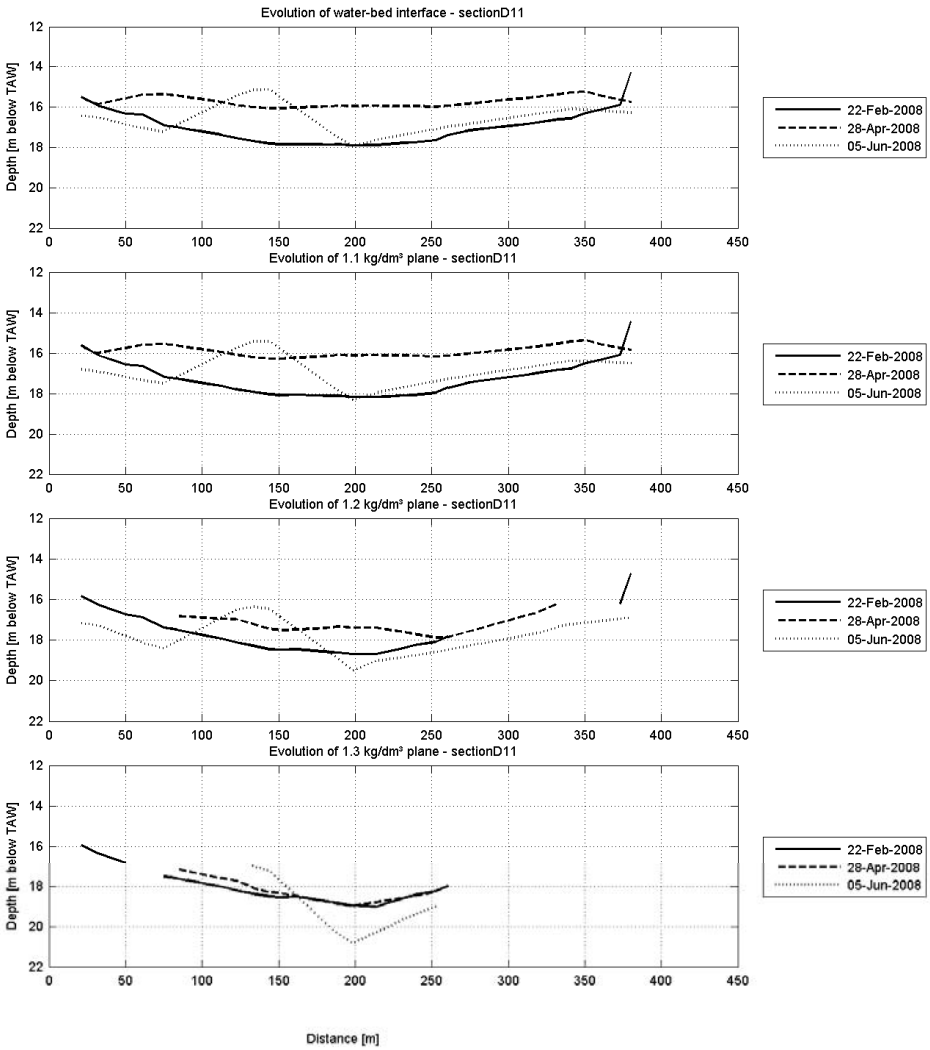


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

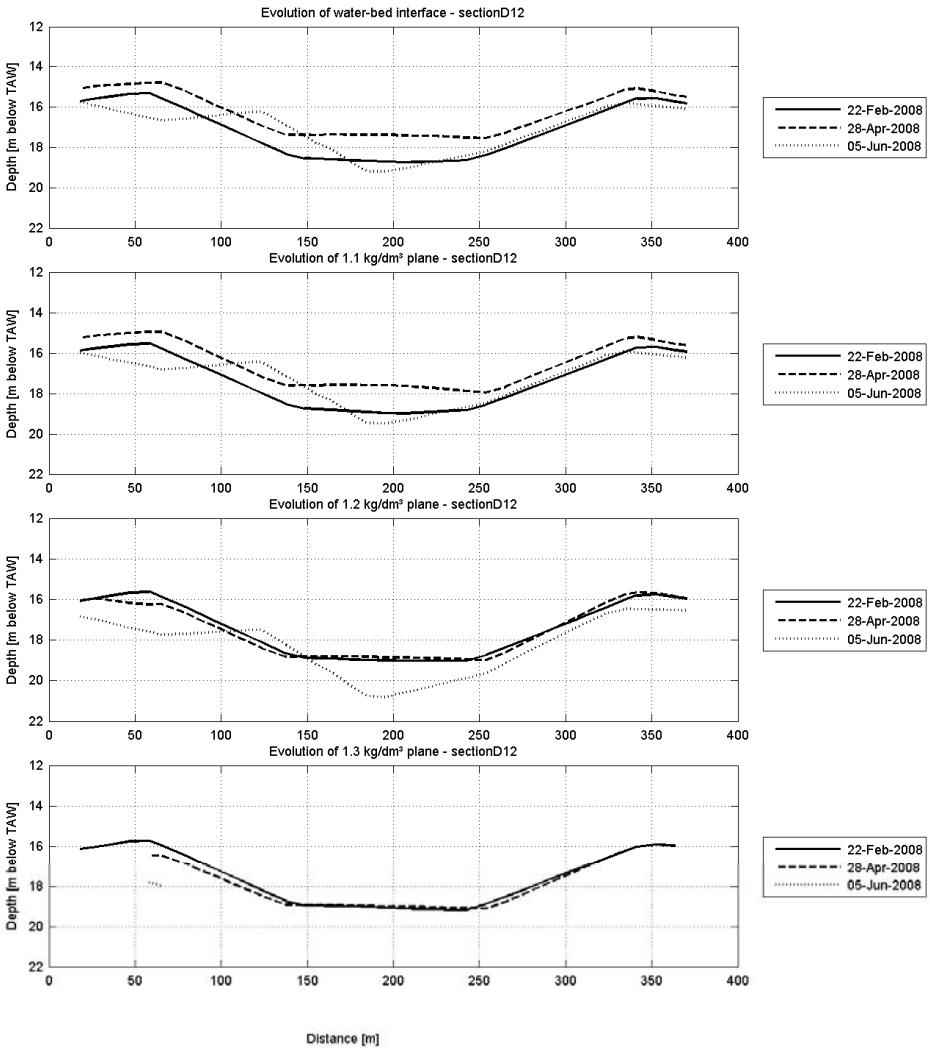


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

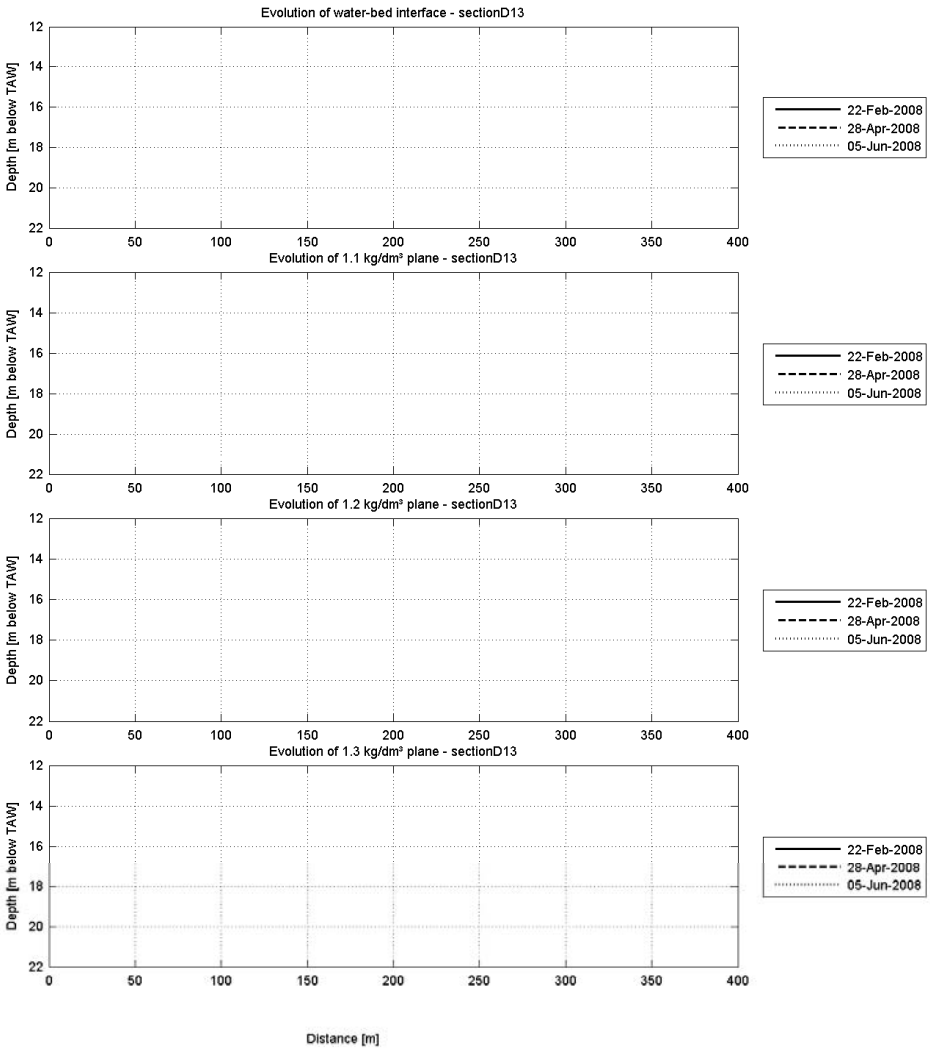


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

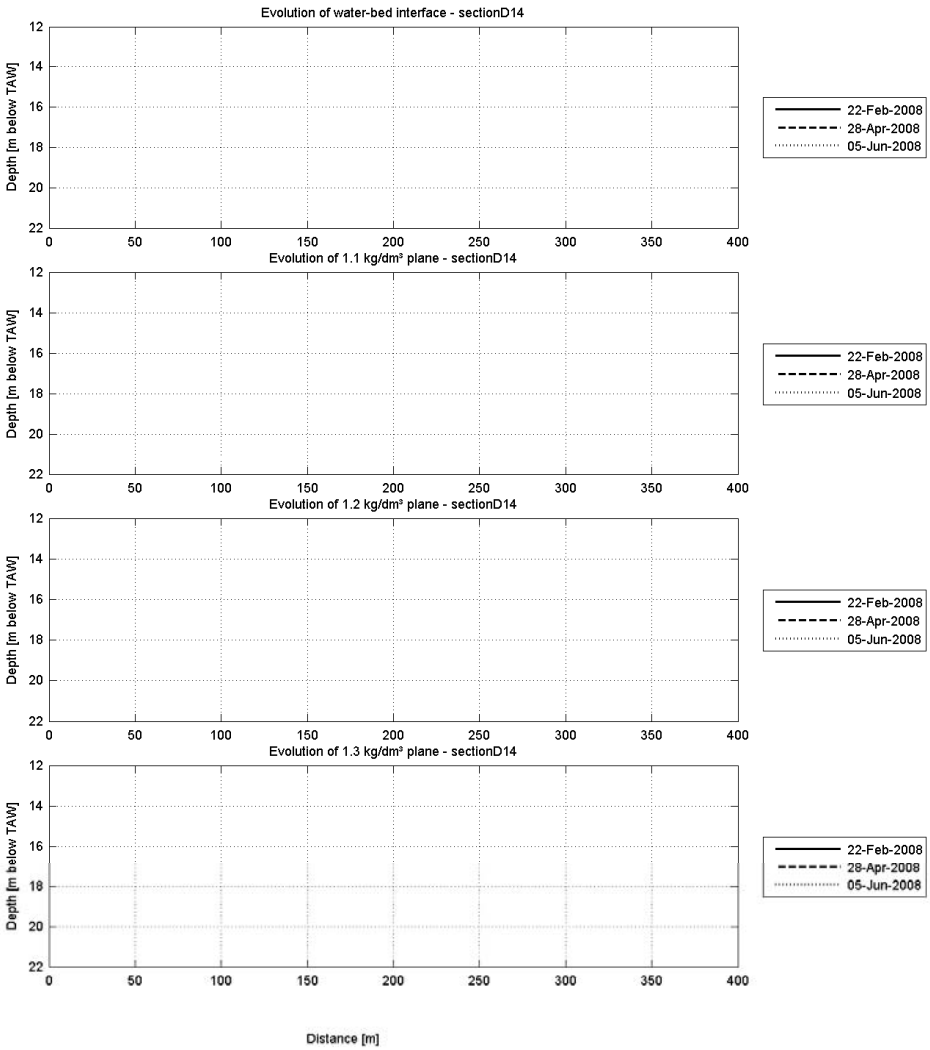


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

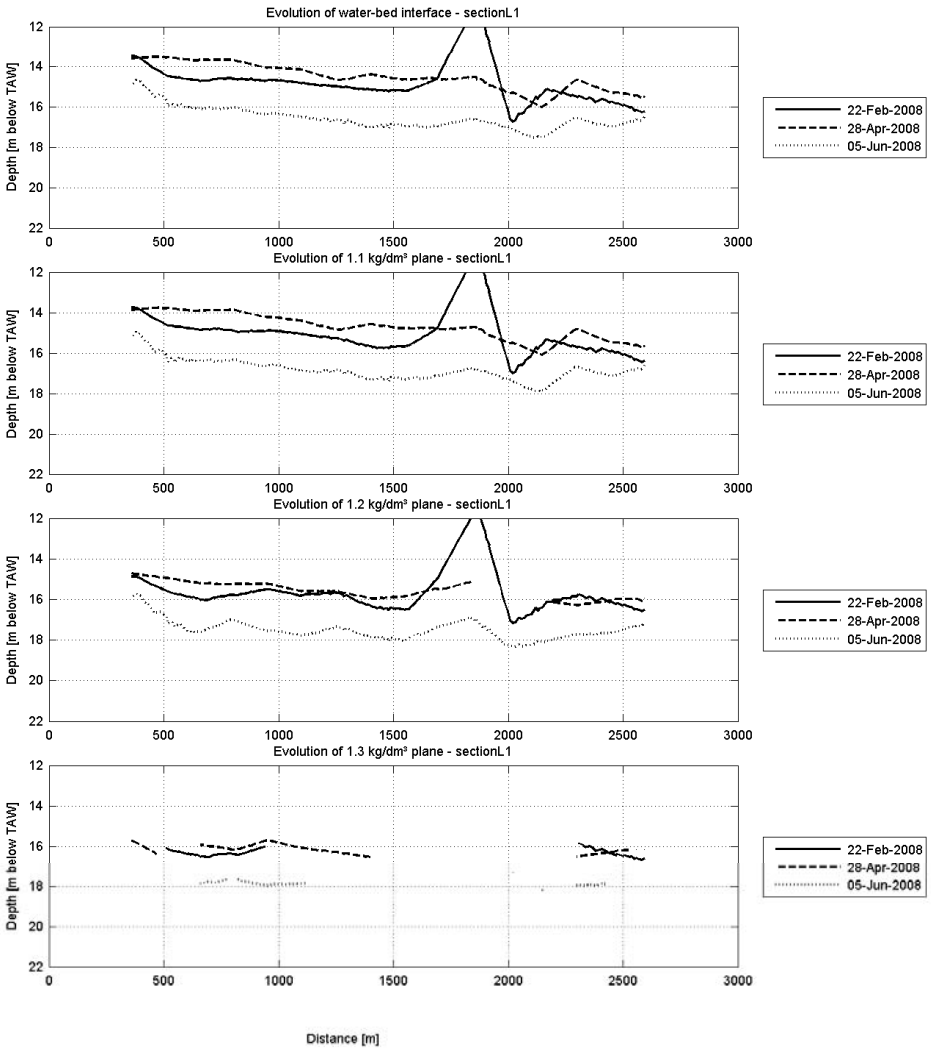


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

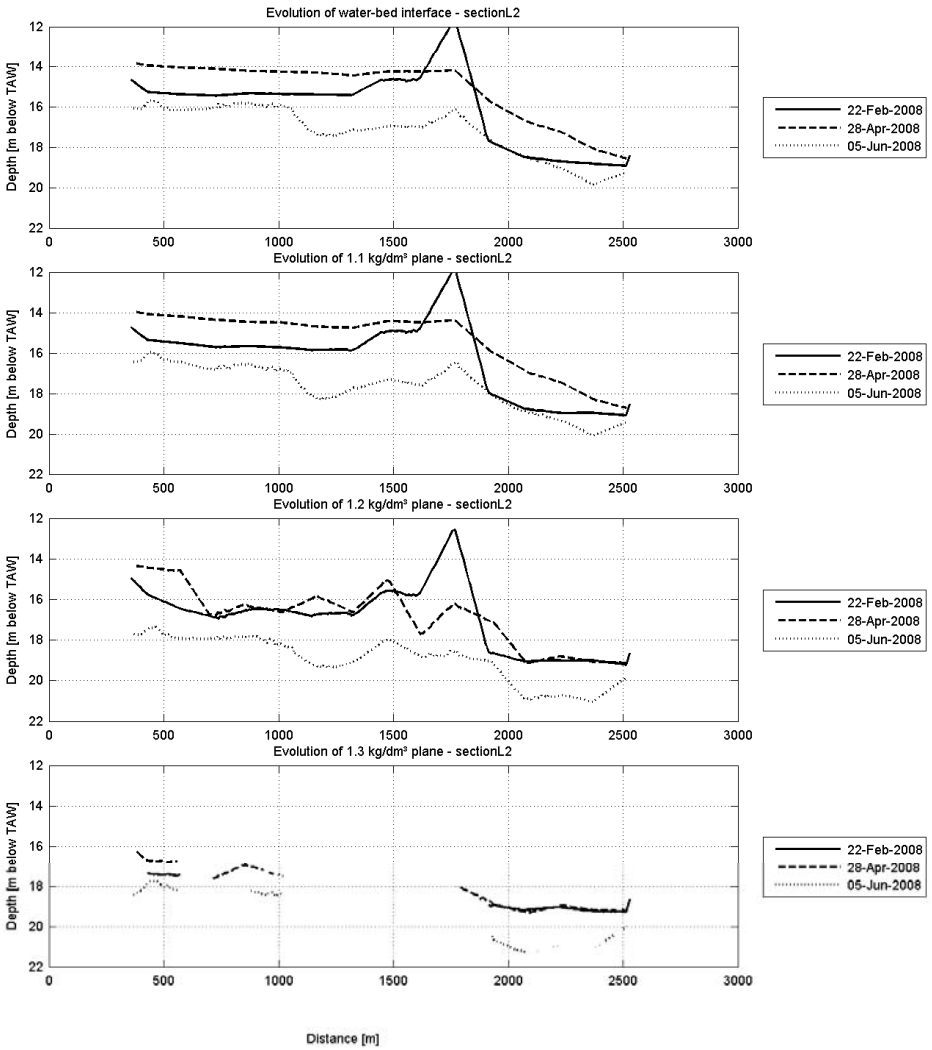


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD

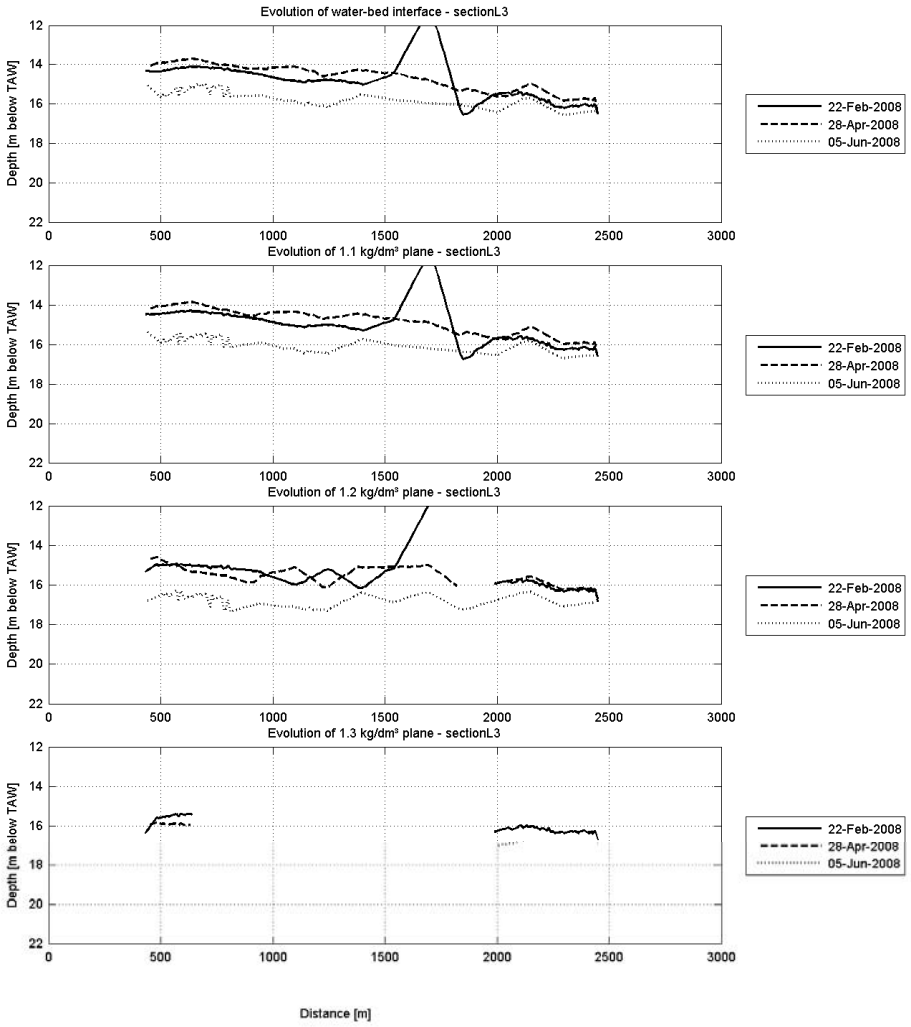


Data Processed by:
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Evolution of planes of constant density	Equipment(s): NaviTracker
	Location: DGD



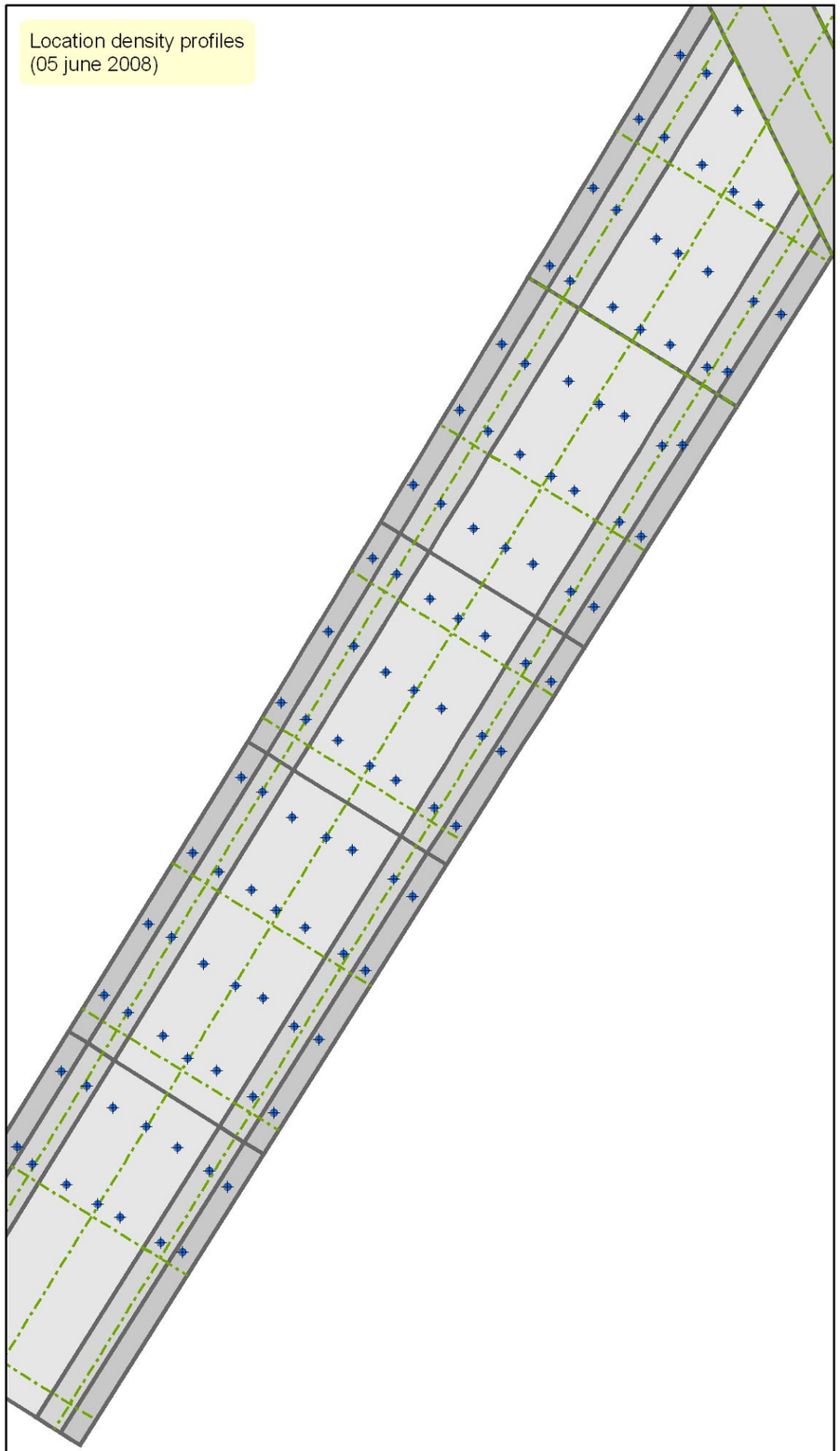
Data Processed by: IMDC
In association with :

I/RA/11283/08.076/MSA

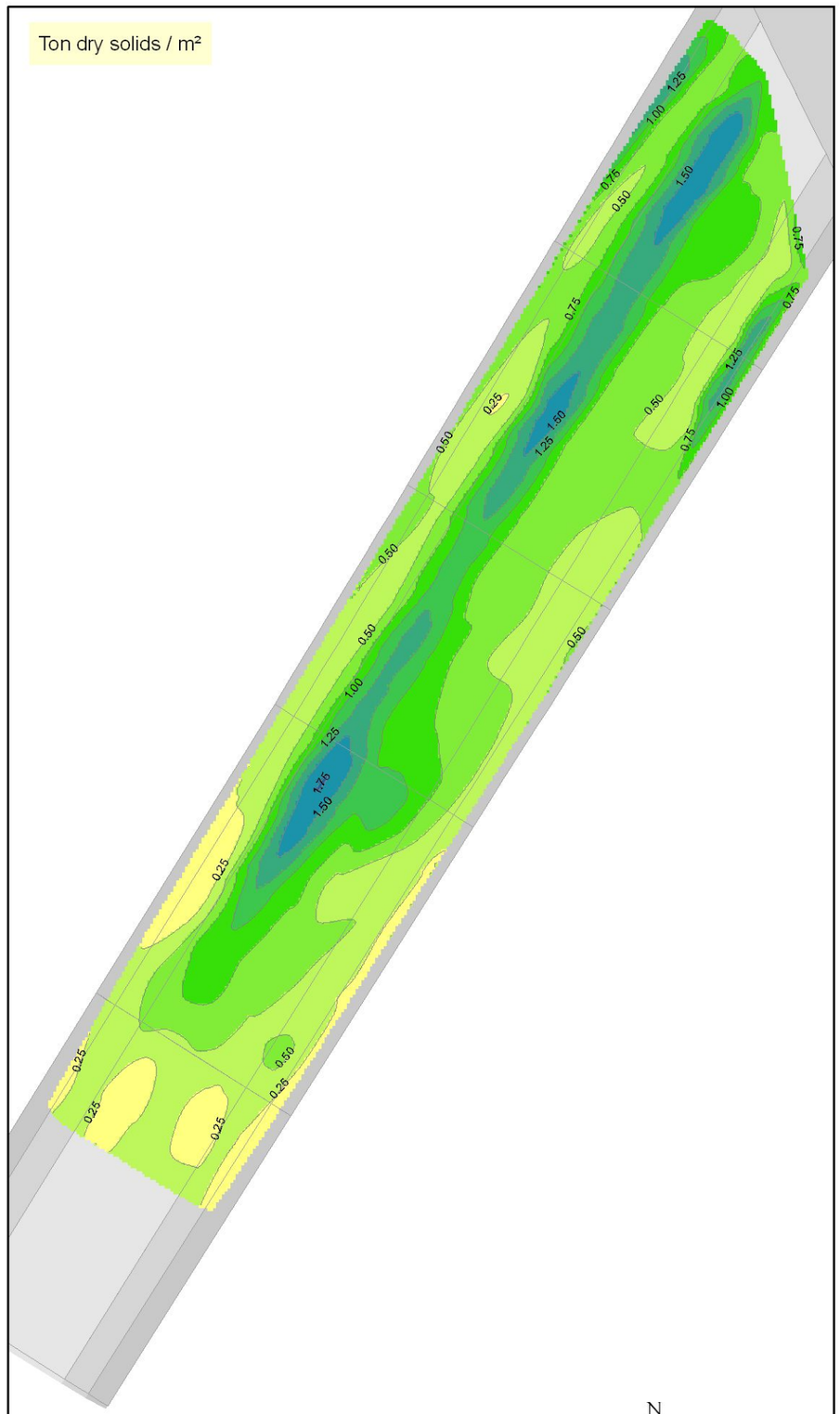
APPENDIX G.

SEDIMENT MASS DISTRIBUTION IN DEURGANCKDOK

Location density profiles
(05 june 2008)



Ton dry solids / m²



Long-term measurements
Deurganckdok
Evolution & analysis of siltation

Bestek nr 16EB/05/04

DENSITY MEASUREMENTS
Ton dry solids per m²
05 june 2008

Map 2 Schaal 1/10.000

Created: 30/09/2008 I/DR/11283/08.000/JUR
Version nr. 1

Wilrijkstraat 37
2140 Antwerpen
Tel:+32.3.2709295
Fax:+32.3.2356711
E-mail: info@imdc.be

Legend

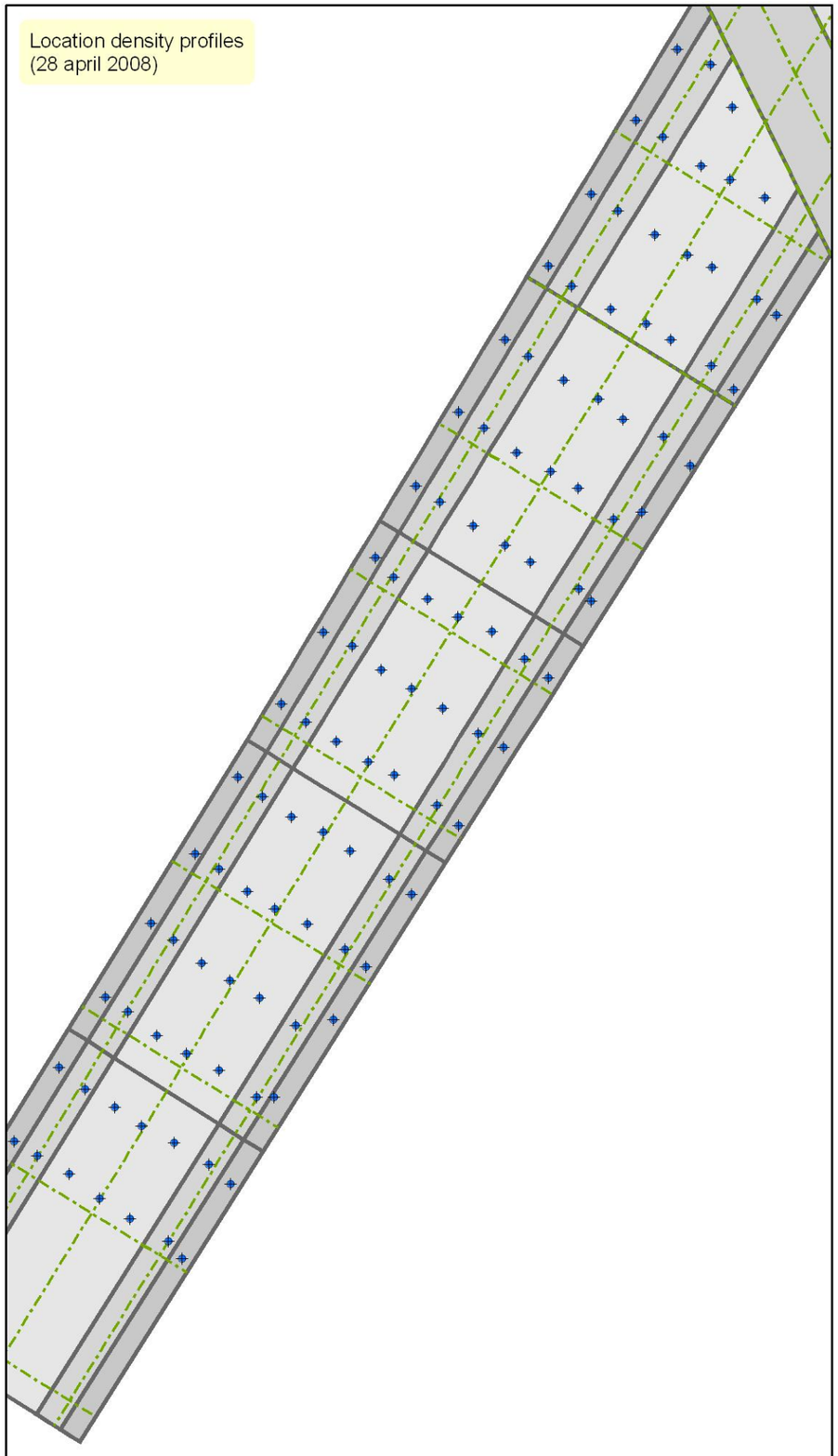
Ton dry solids per m²

- 0 - 0.25
- 0.26 - 0.50
- 0.51 - 0.75
- 0.76 - 1.00
- 1.01 - 1.25
- 1.26 - 1.50
- 1.51 - 1.75
- 1.76 - 2.00
- 2.01 - 2.25
- 2.26 - 2.50

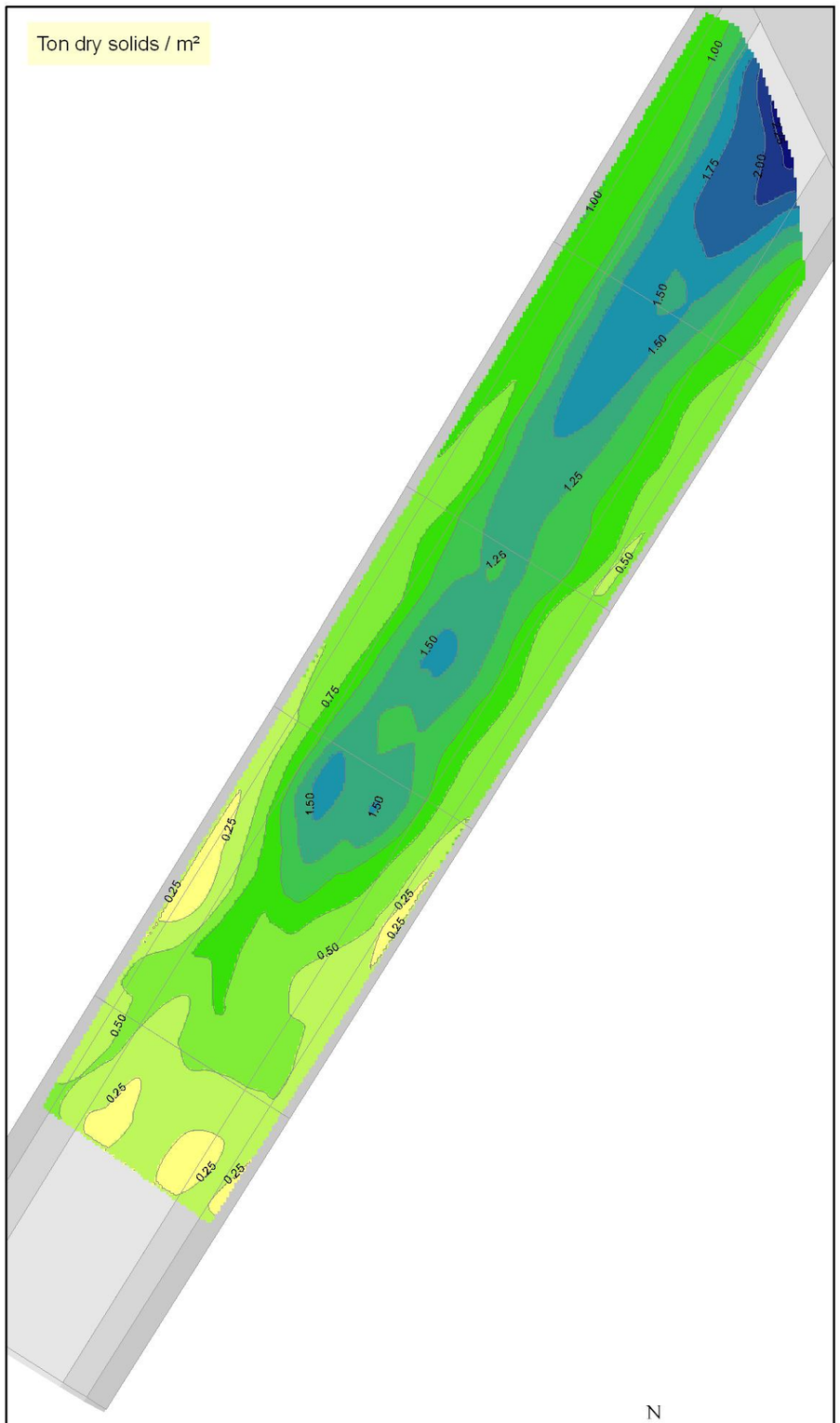
- 05-Jun-2008_XY.txt Events
- Transects
- (Site) zones

File: W:\11283\GIS\project\rapport 1-20\TDS\Measurement-08\K1_TDS_050608.mxd

Location density profiles
(28 april 2008)



Ton dry solids / m²



Long-term measurements
Deurganckdok
Evolution & analysis of siltation

Bestek nr 16EB/05/04

DENSITY MEASUREMENTS
Ton dry solids per m²
28 april 2008

Map 1 Schaal 1/10.000

Created: 30/09/2008 I/DR/11283/08.000/JUR
Version nr. 1

Wilrijkstraat 37
2140 Antwerpen
Tel:+32.3.2709295
Fax:+32.3.2356711
E-mail: info@imdc.be

Legend

Ton dry solids per m²

- 0 - 0.25
- 0.26 - 0.50
- 0.51 - 0.75
- 0.76 - 1.00
- 1.01 - 1.25
- 1.26 - 1.50
- 1.51 - 1.75
- 1.76 - 2.00
- 2.01 - 2.25
- 2.26 - 2.50

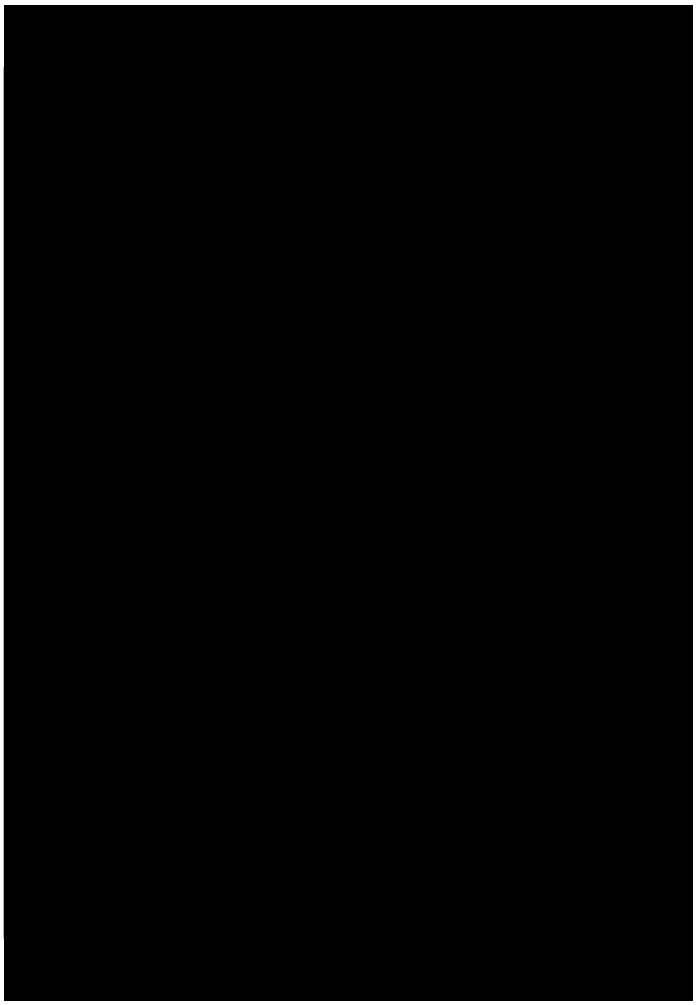
- 28-Apr-2008_XY.txt Events
- Transects
- (Site) zones

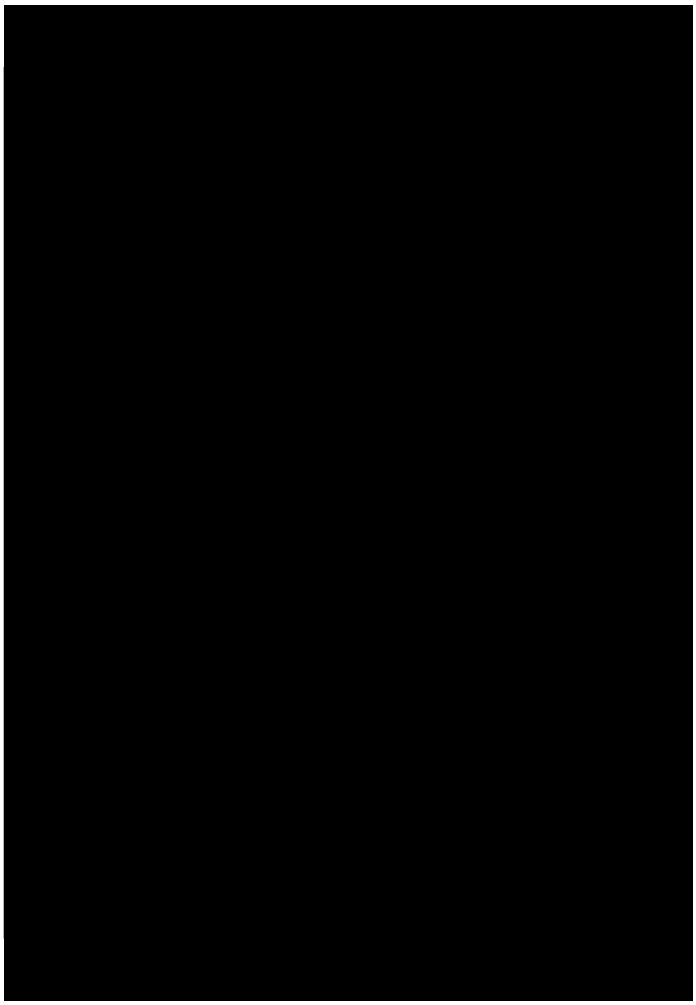
File: W:\11283\GIS\project\rapport 1-20\TDS\Measurement-07\K1_TDS_280408.mxd

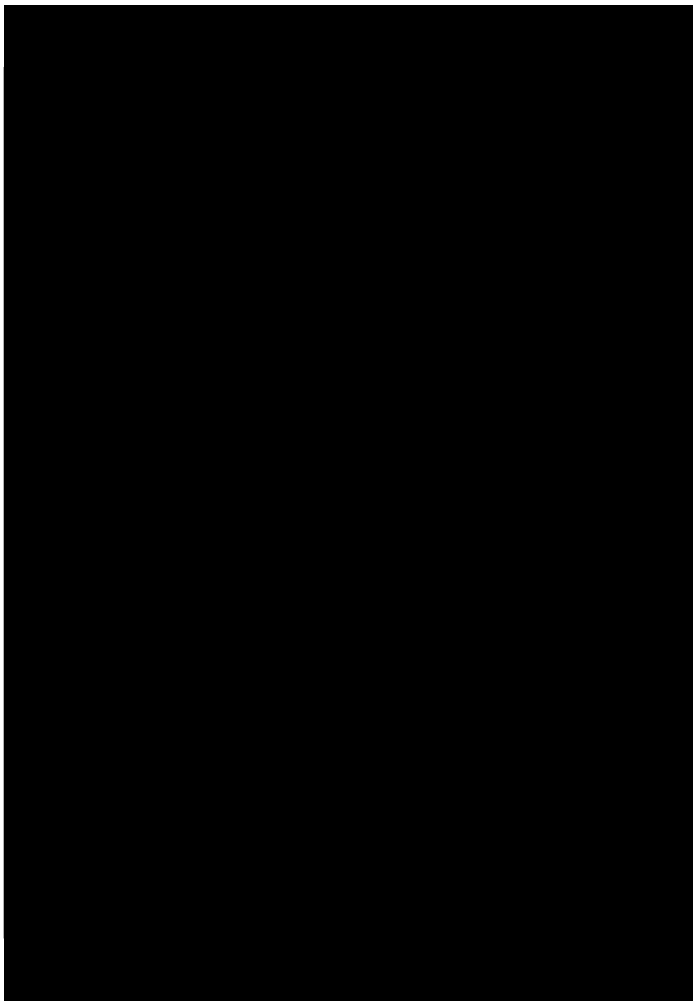
APPENDIX H.

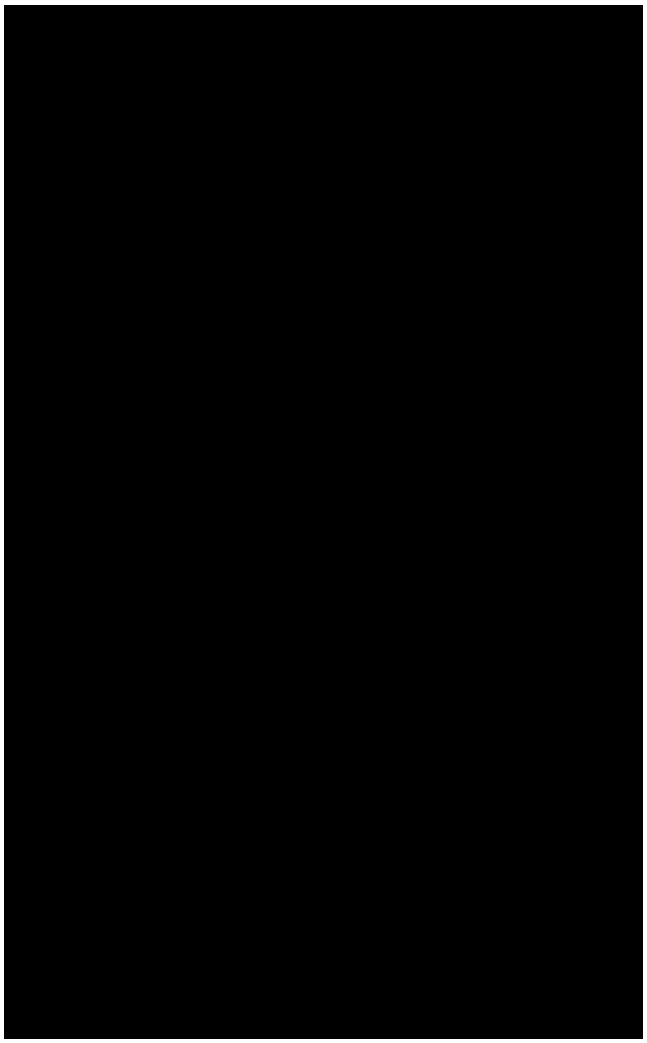
AVERAGE MASS GROWTH AND GROWTH RATE

H.1 Tabular results





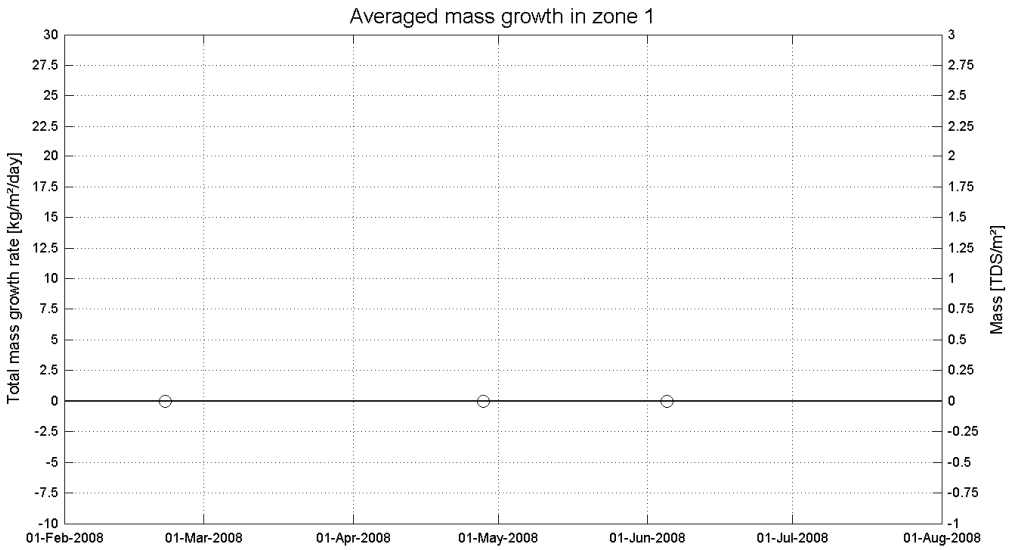


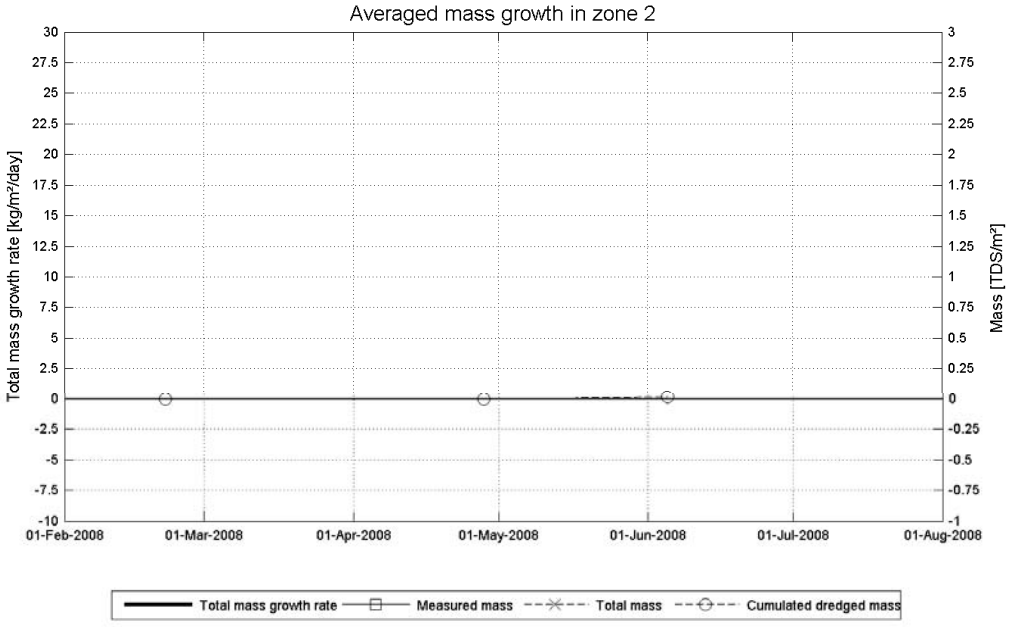


H.2 For each zone

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





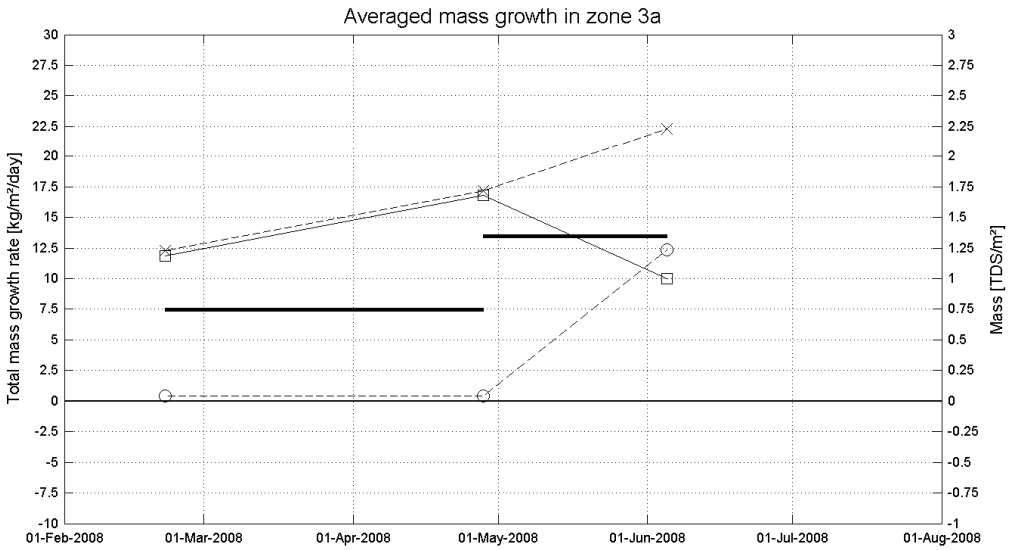
Data Processed by:

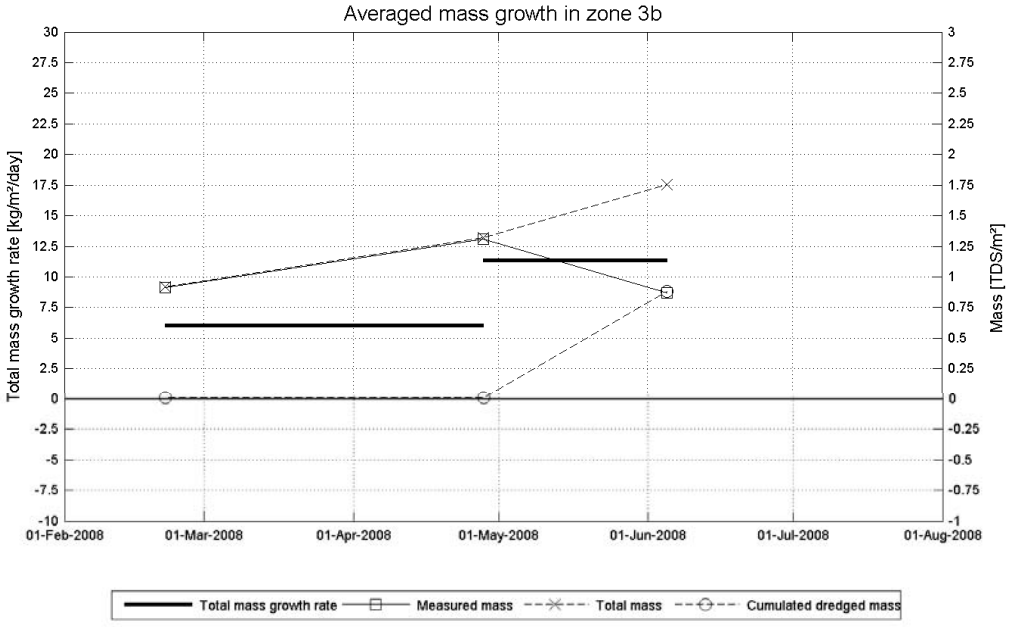
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





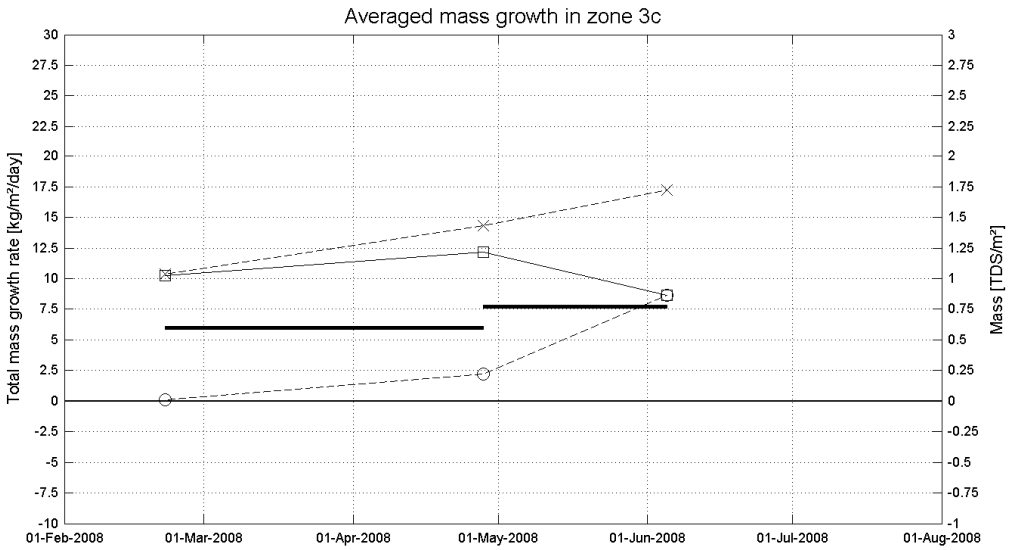
Data Processed by:

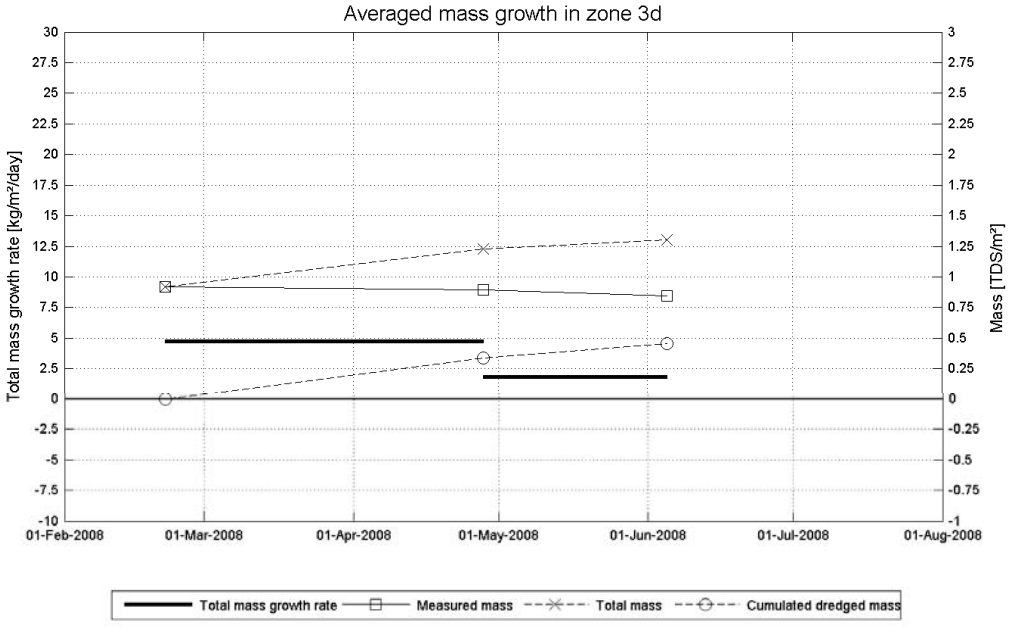
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





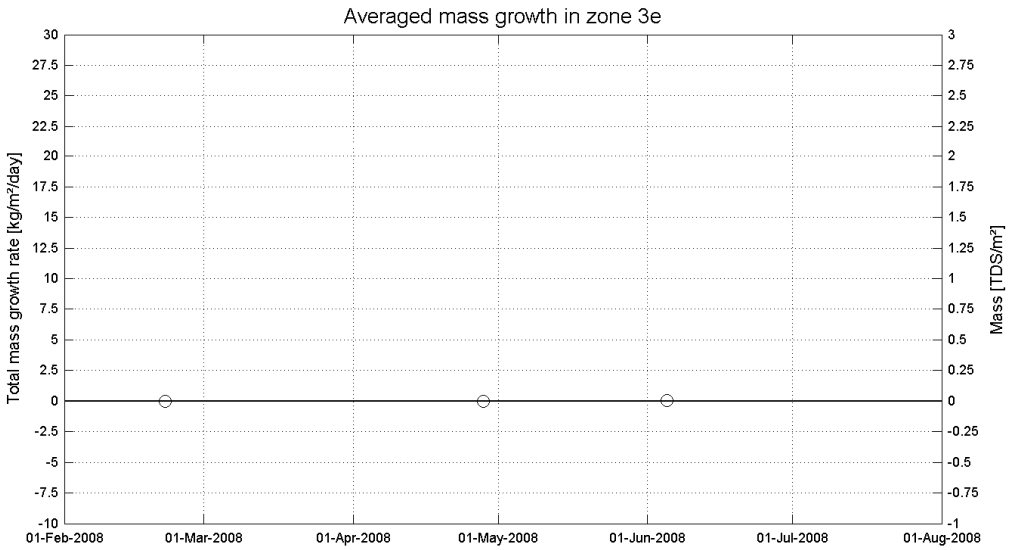
Data Processed by:

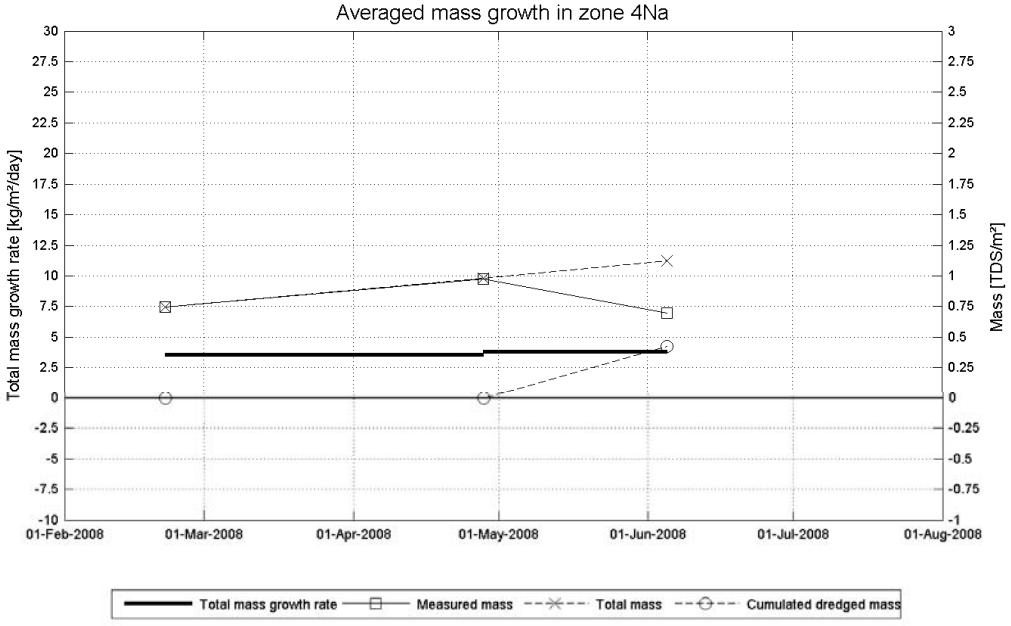
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





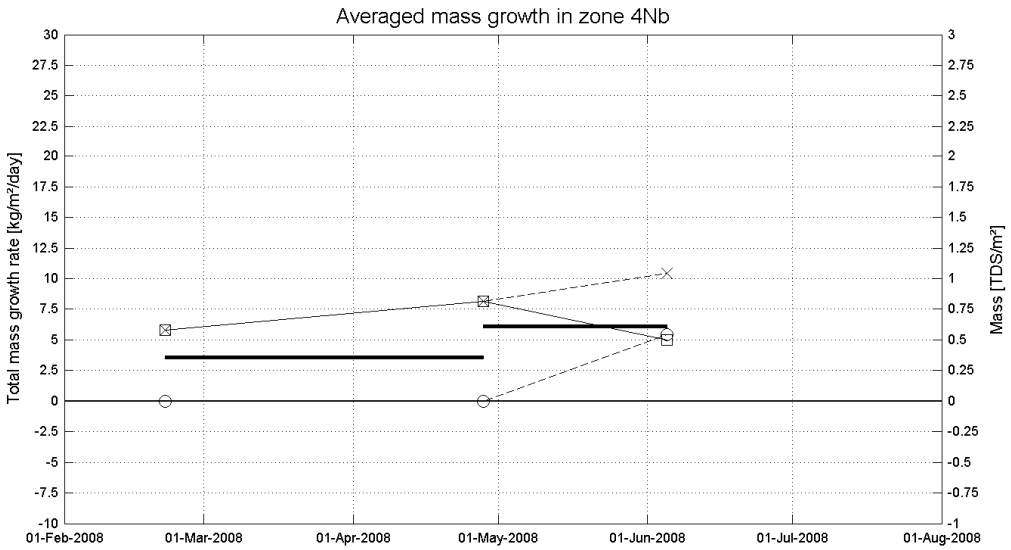
Data Processed by:

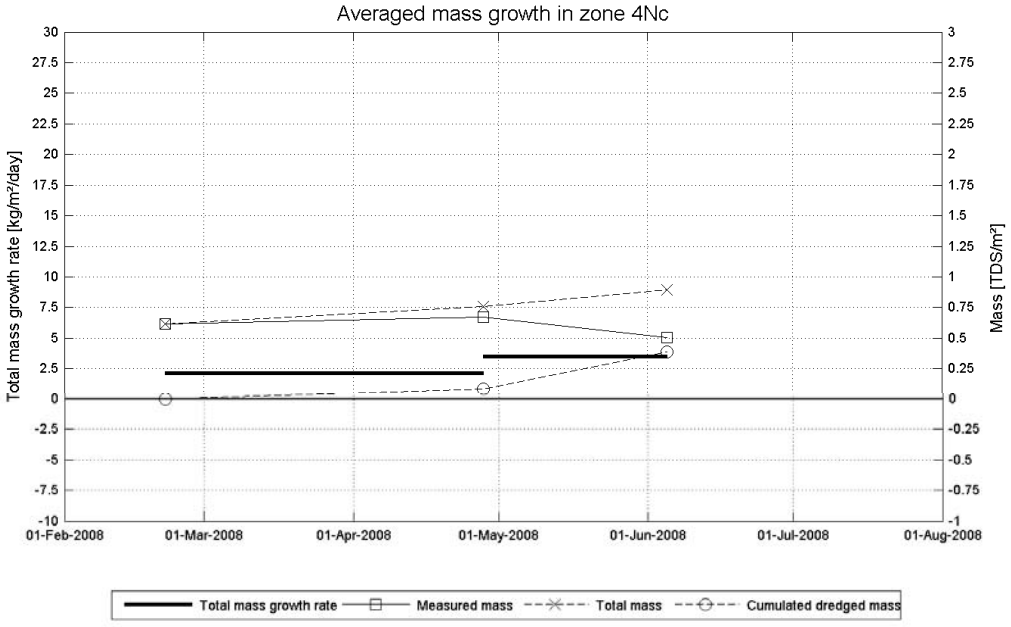
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





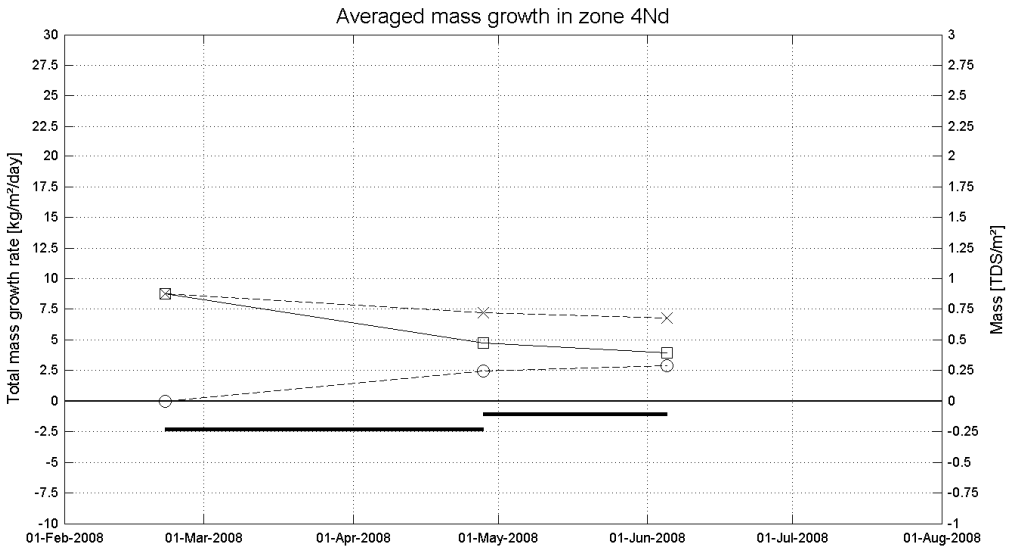
Data Processed by:

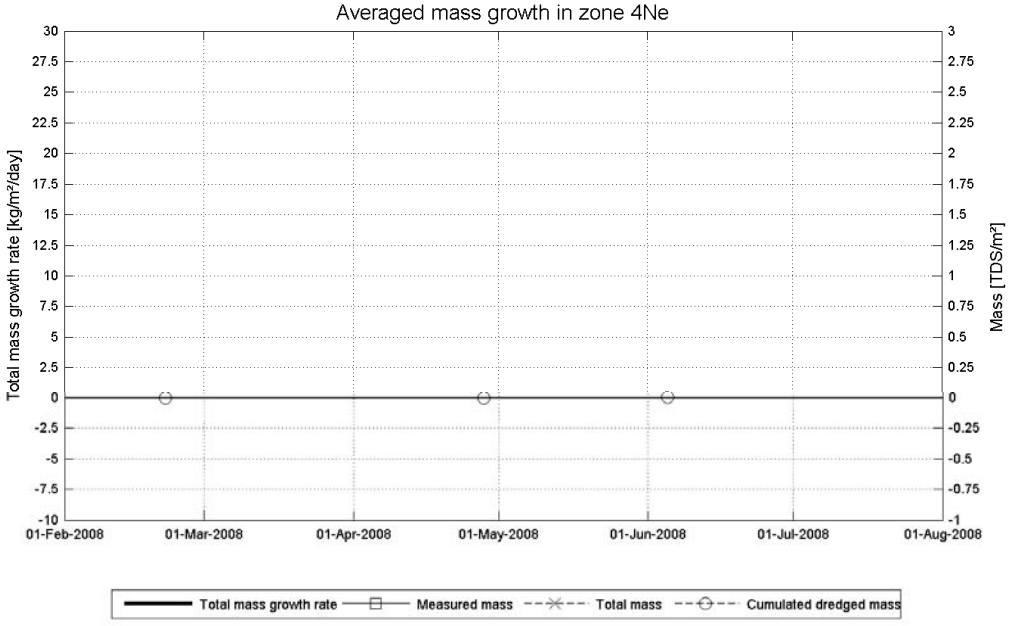
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





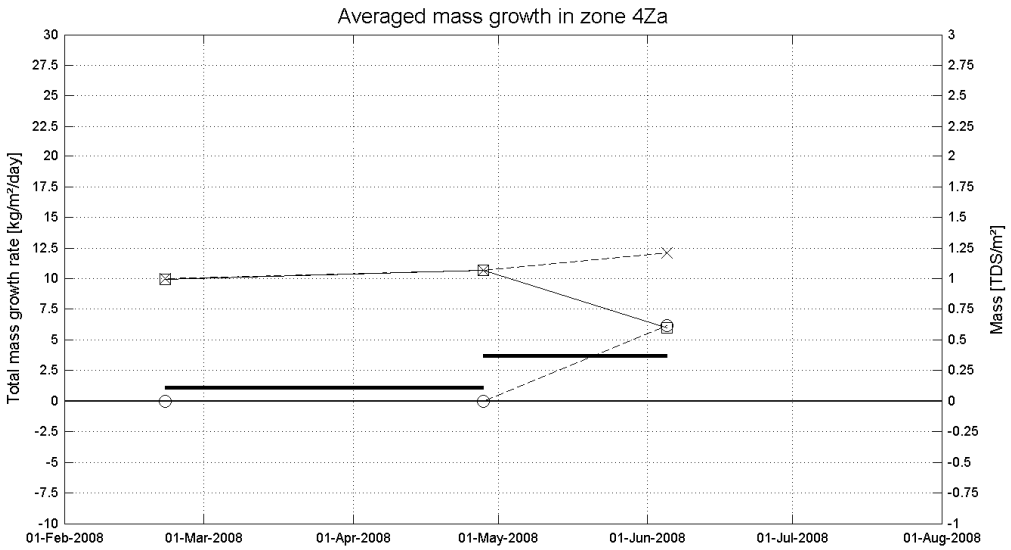
Data Processed by:

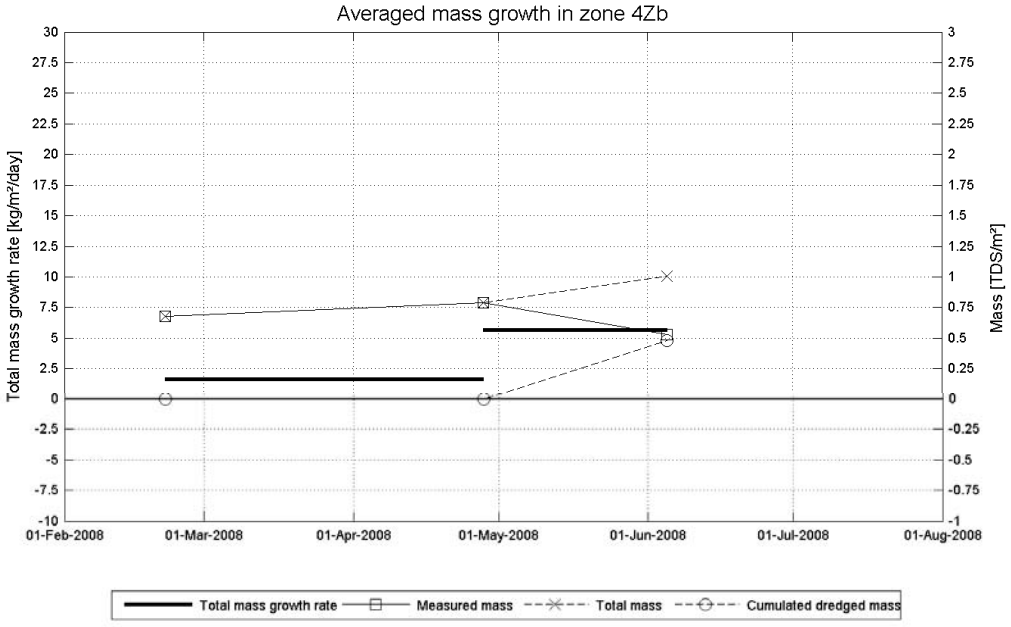
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





Data Processed by:

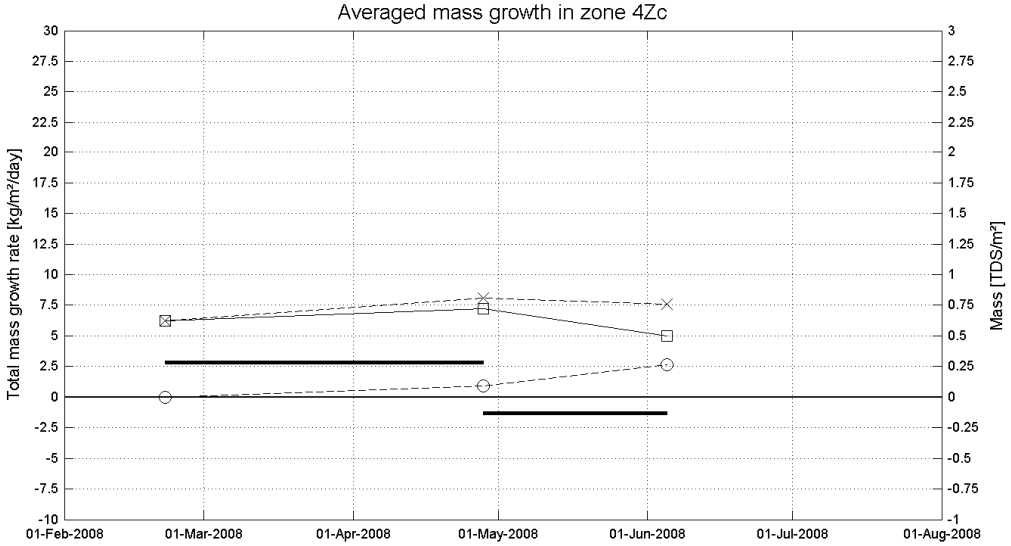
In association with :

I/RA/11283/08.076/MSA

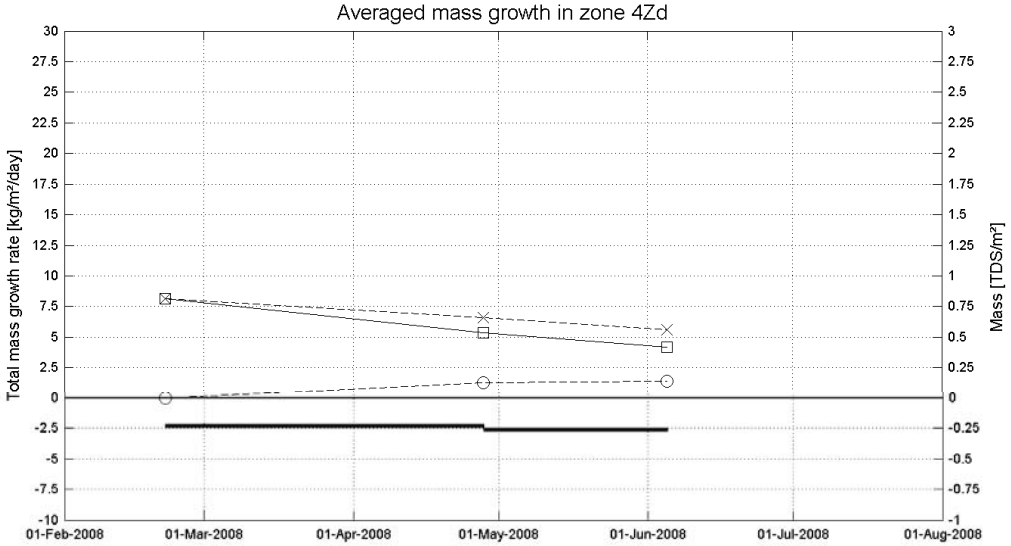
Long-term monitoring siltation Deurganckdok

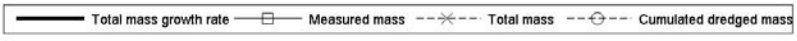
Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD

Averaged mass growth in zone 4Zc



Averaged mass growth in zone 4Zd





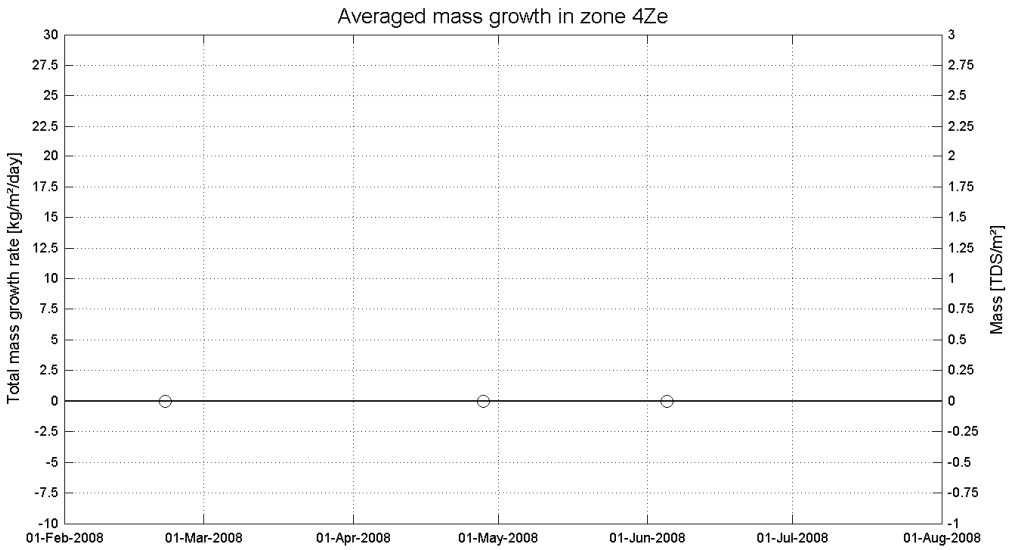
Data Processed by:

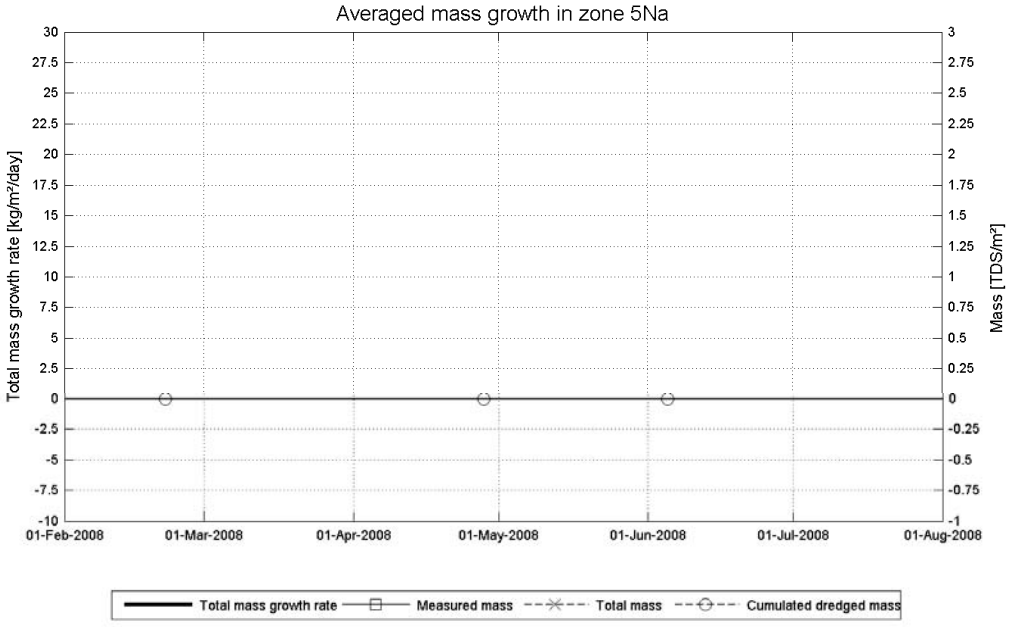
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





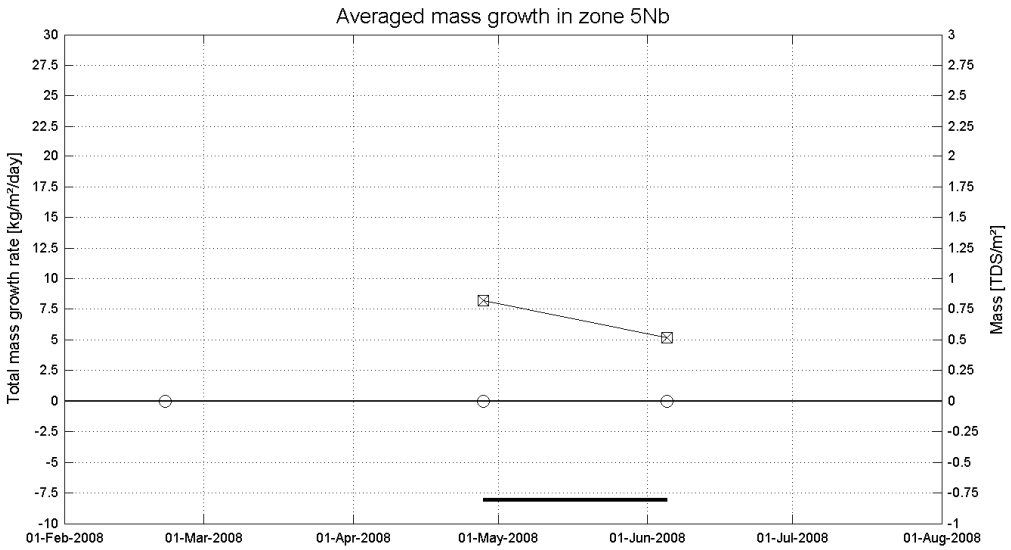
Data Processed by:

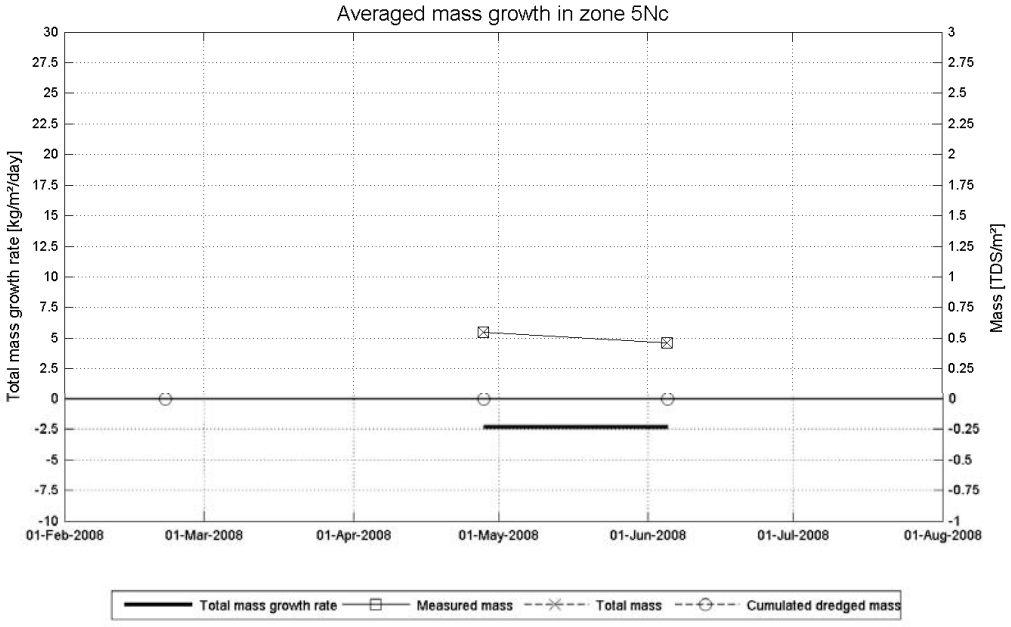
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





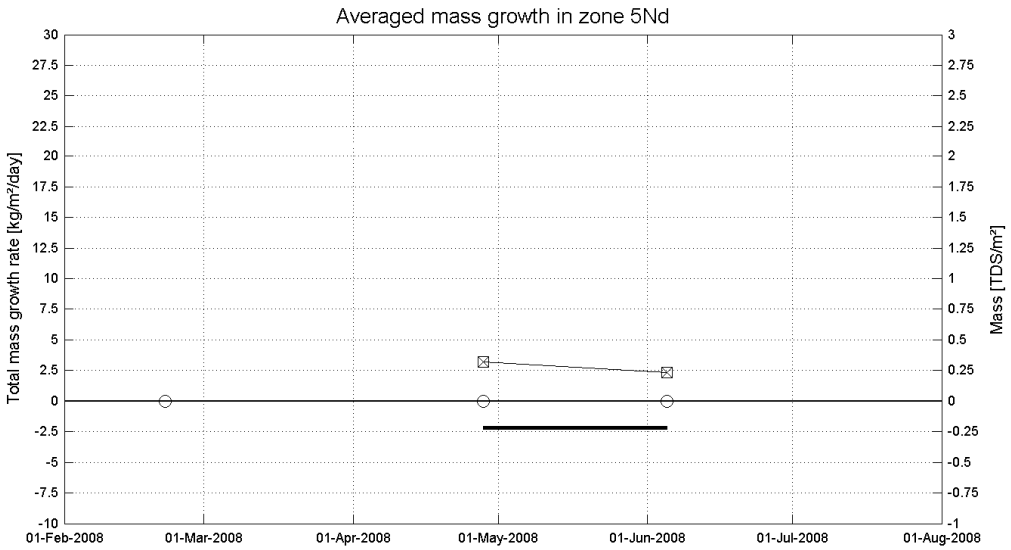
Data Processed by:

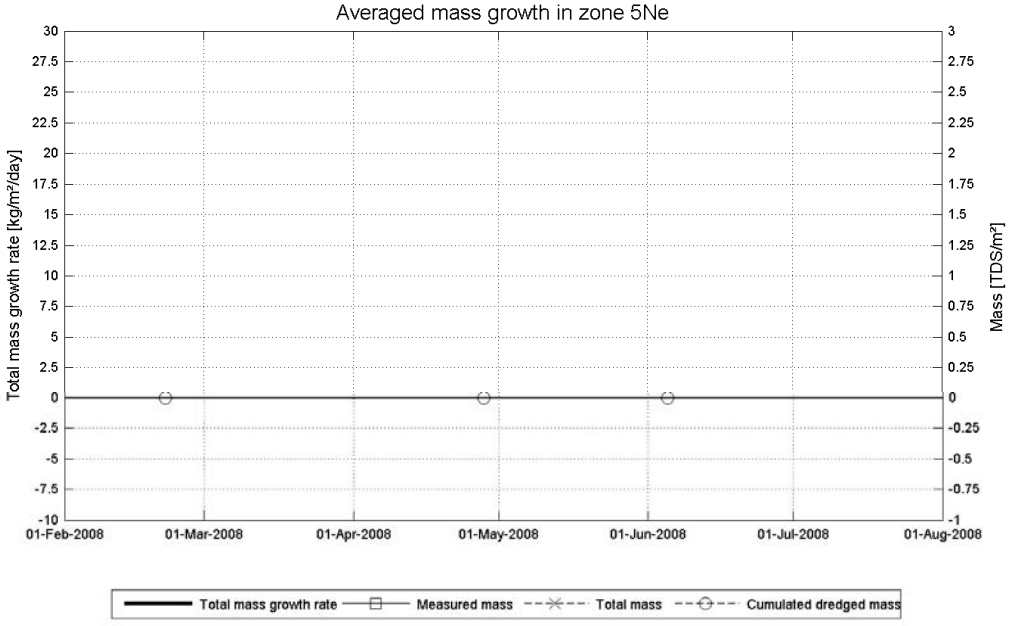
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





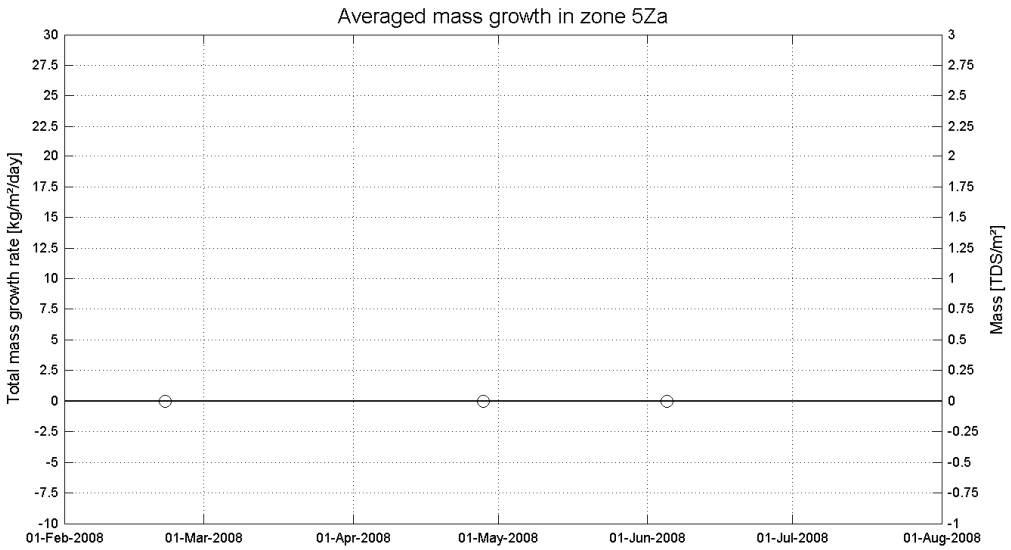
Data Processed by:

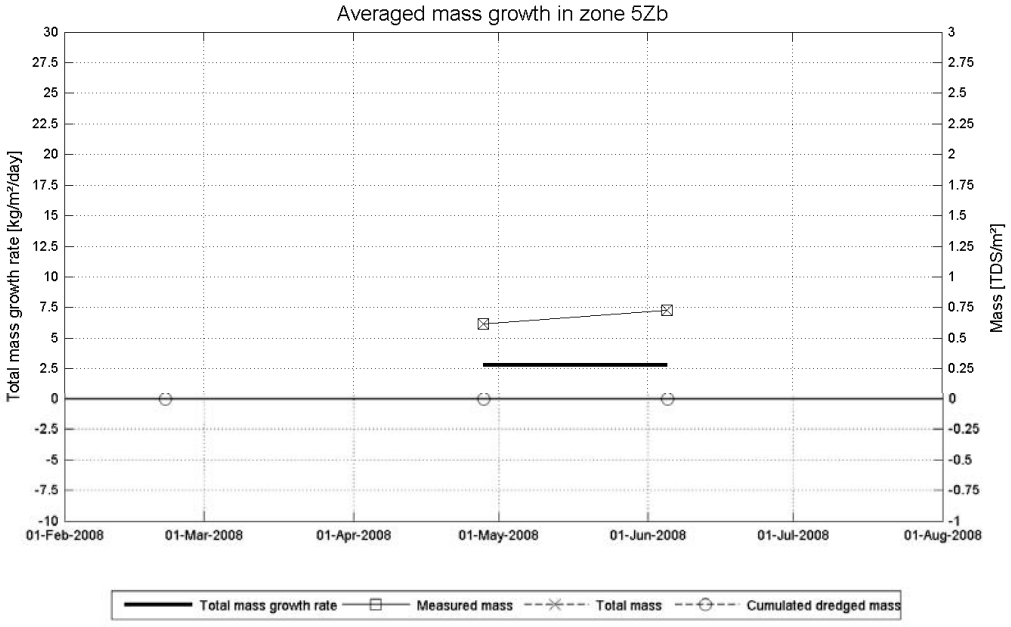
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





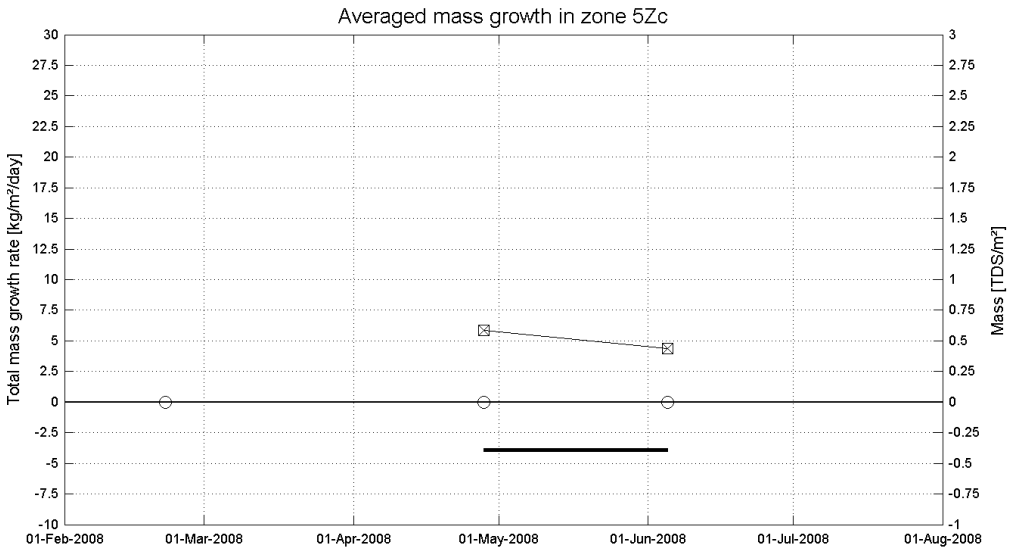
Data Processed by:

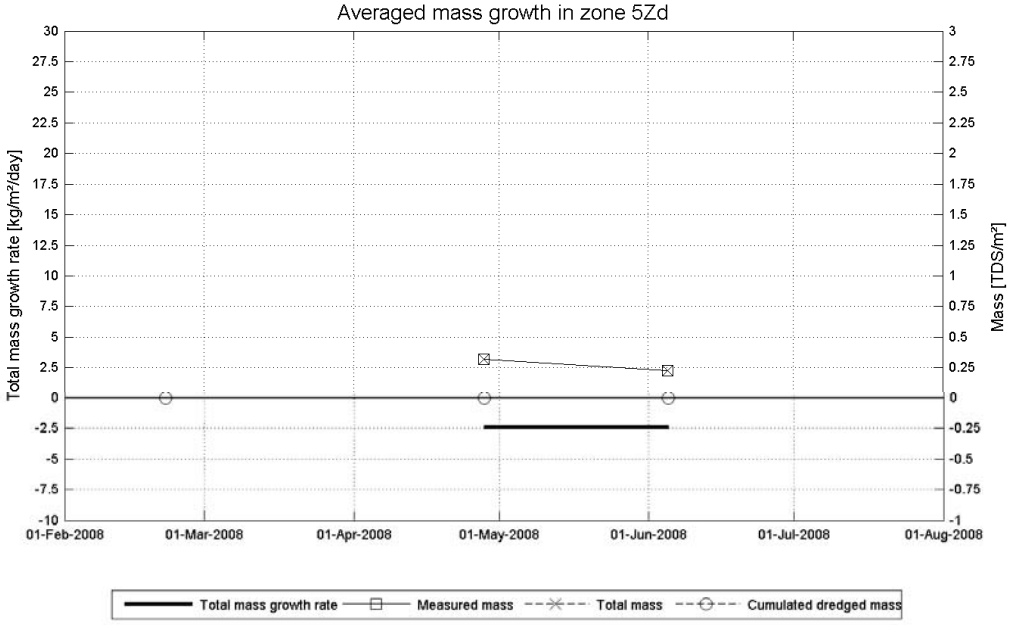
In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD





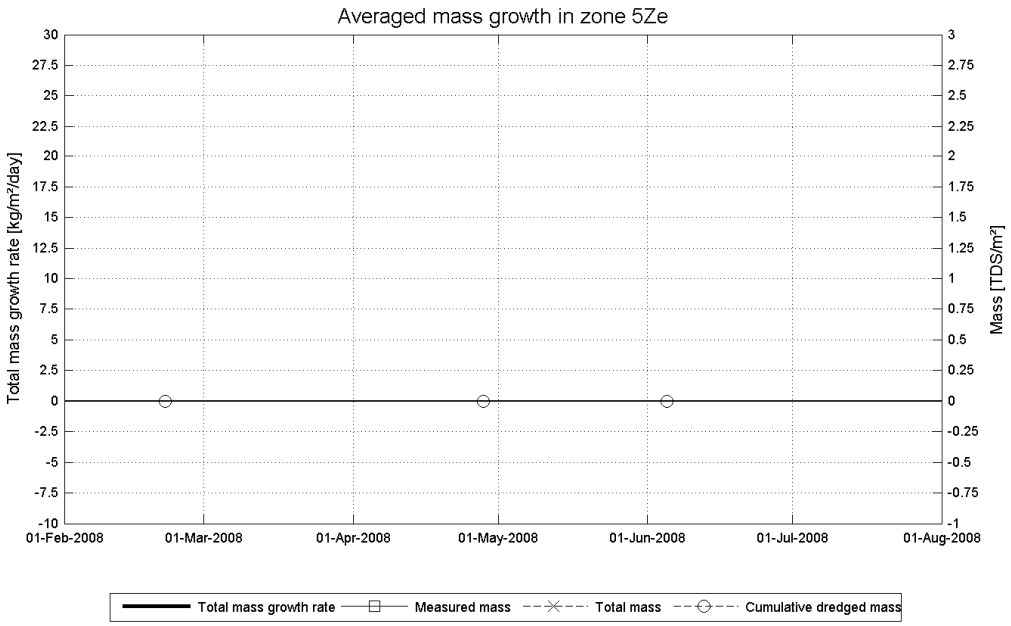
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD



Data Processed by:

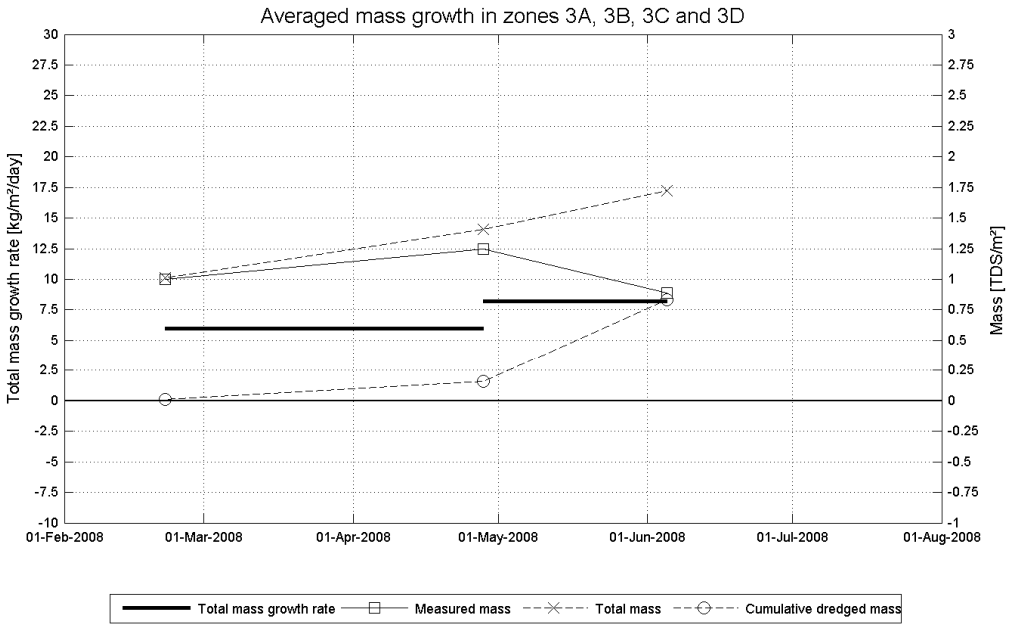
In association with :

I/RA/11283/08.076/MSA

H.3 For complete Deurganckdok

Long-term monitoring siltation Deurganckdok

Measured/Dredged/Total Mass	Equipment(s): NaviTracker
	Location: DGD



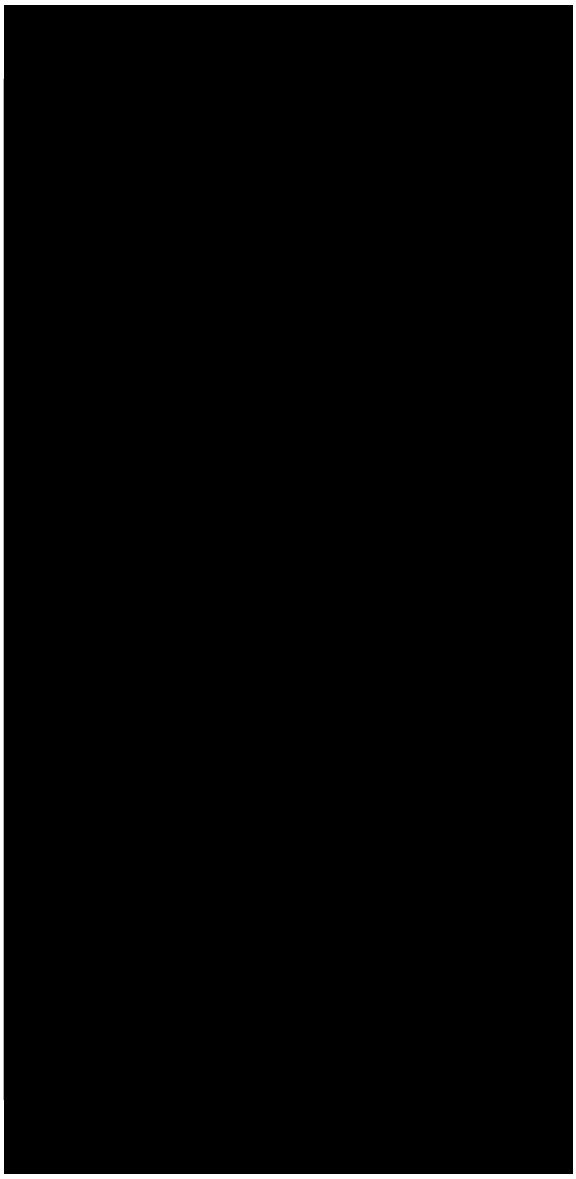
Data Processed by:

In association with :

I/RA/11283/08.076/MSA

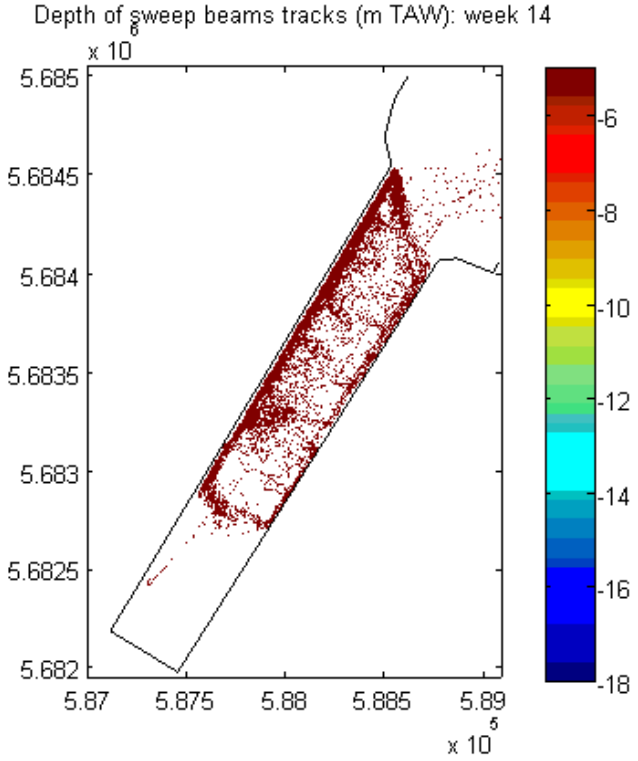
APPENDIX I.

DREDGING DATA



APPENDIX J.

SWEEP BEAM DREDGING DATA



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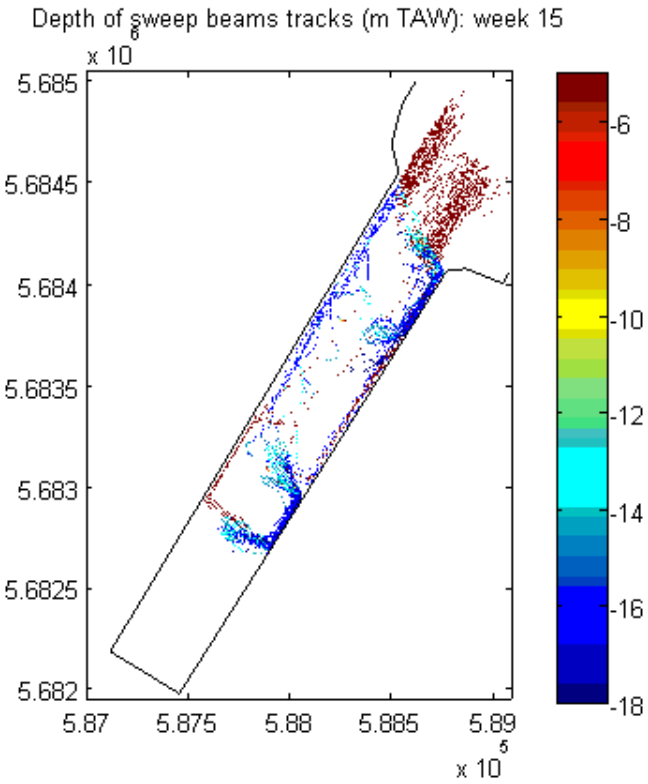
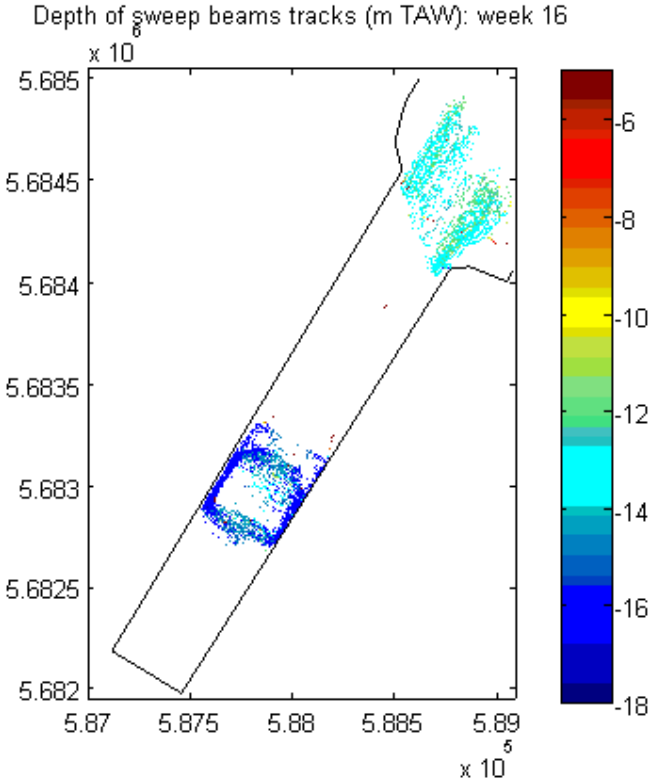
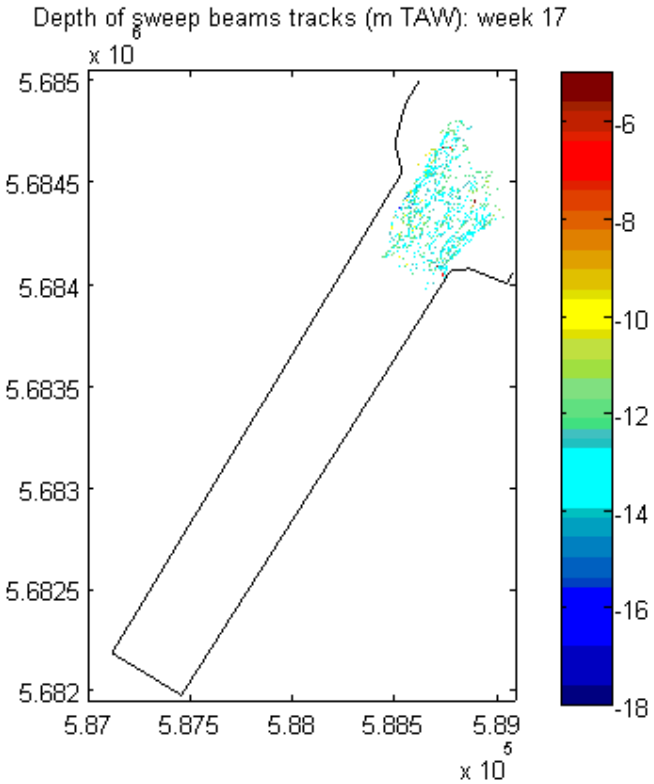
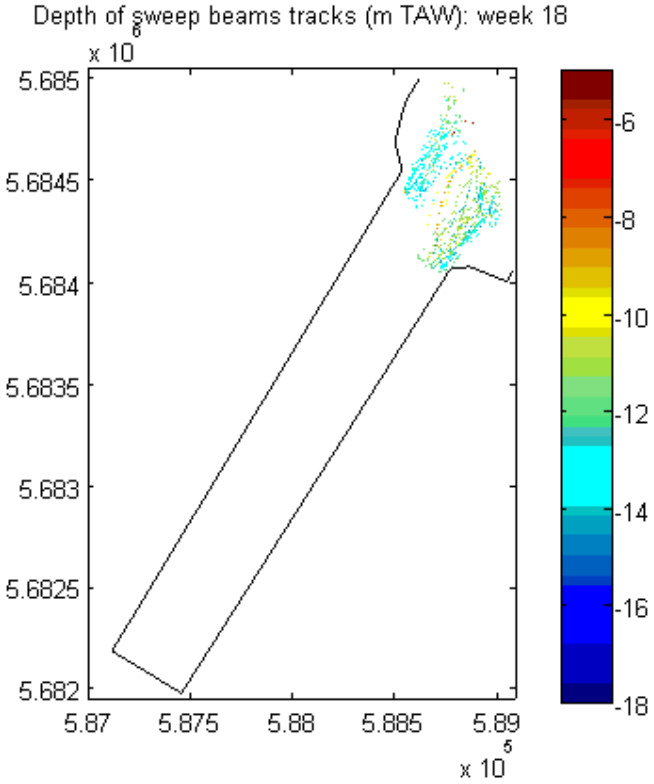
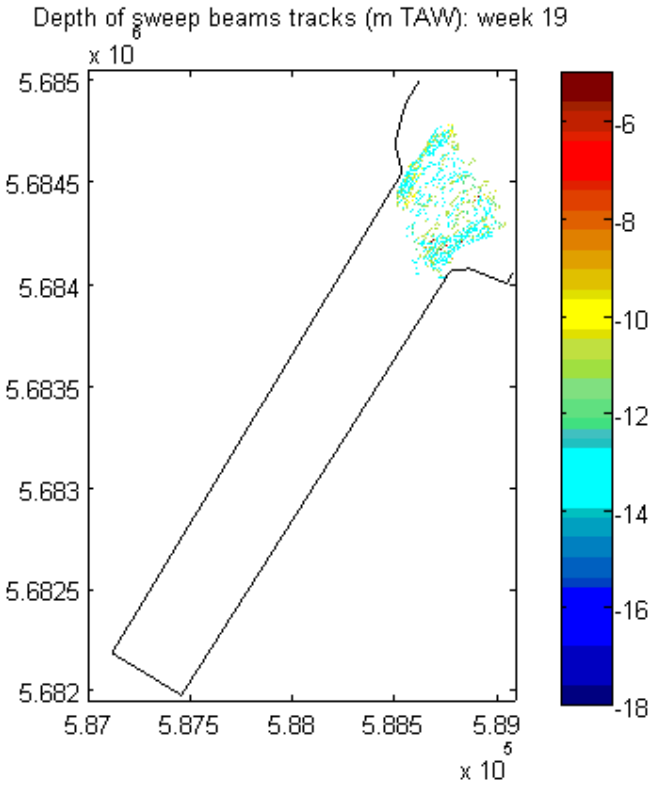
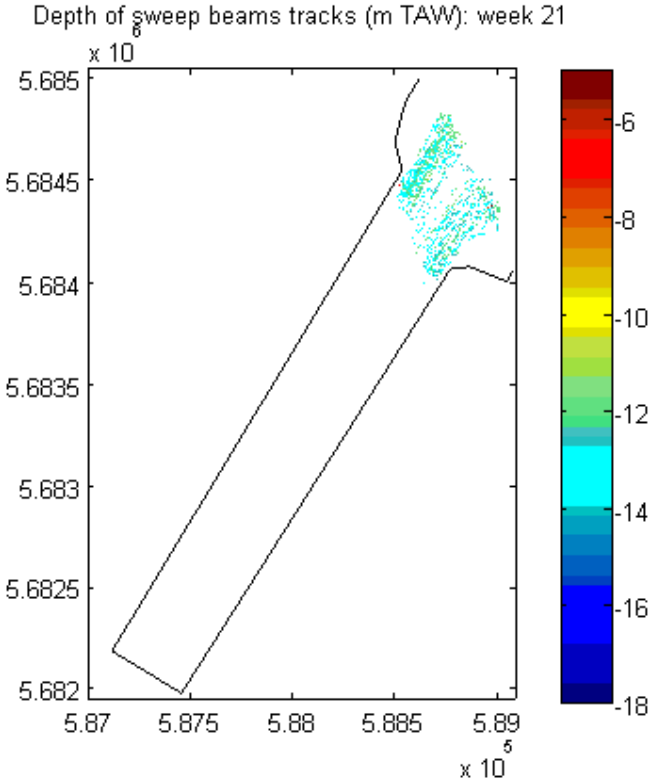


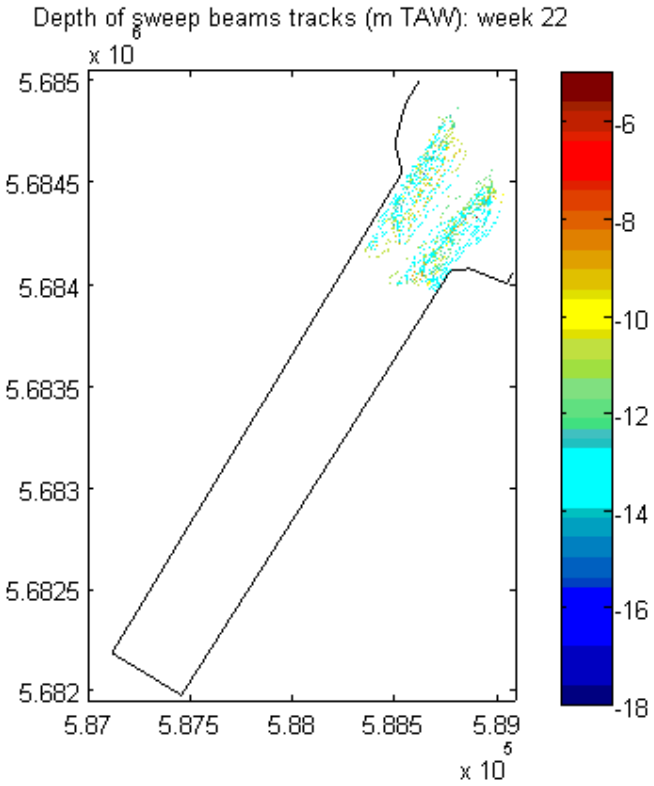

Depth of sweep beams tracks (m TAW): week 16
x 10^6
5.685
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 17
x 10^6
5.685
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 18
x 10^6
5.685
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 19
x 10^6
5.685
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 21
x 10^6
5.685
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 22
x 10^6
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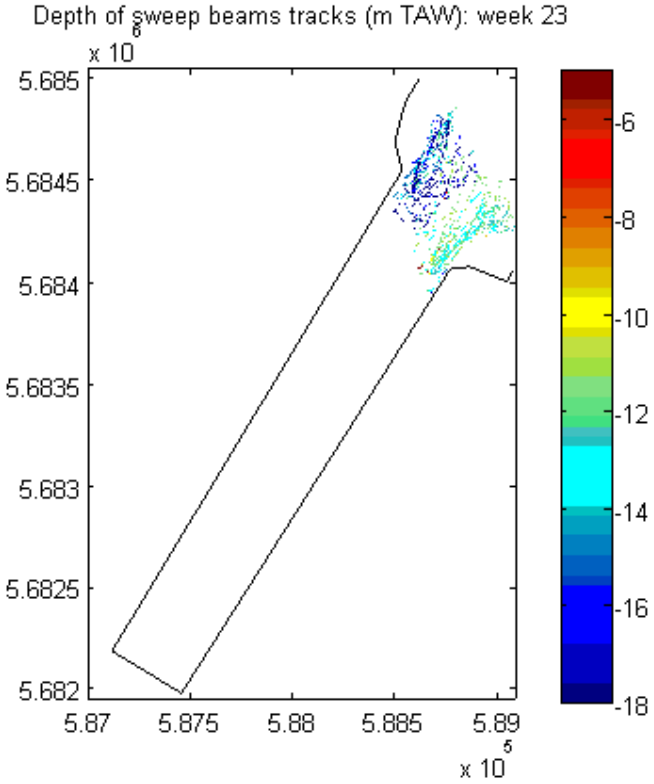
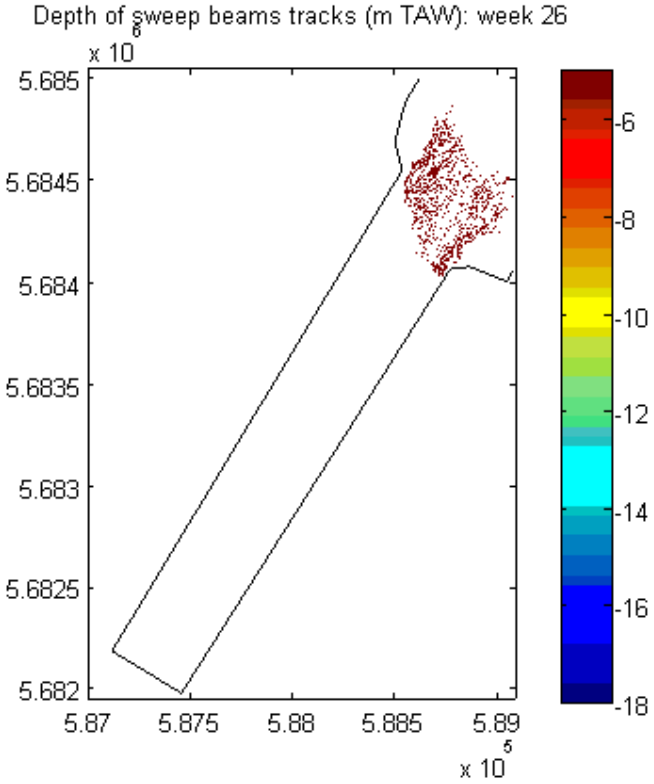
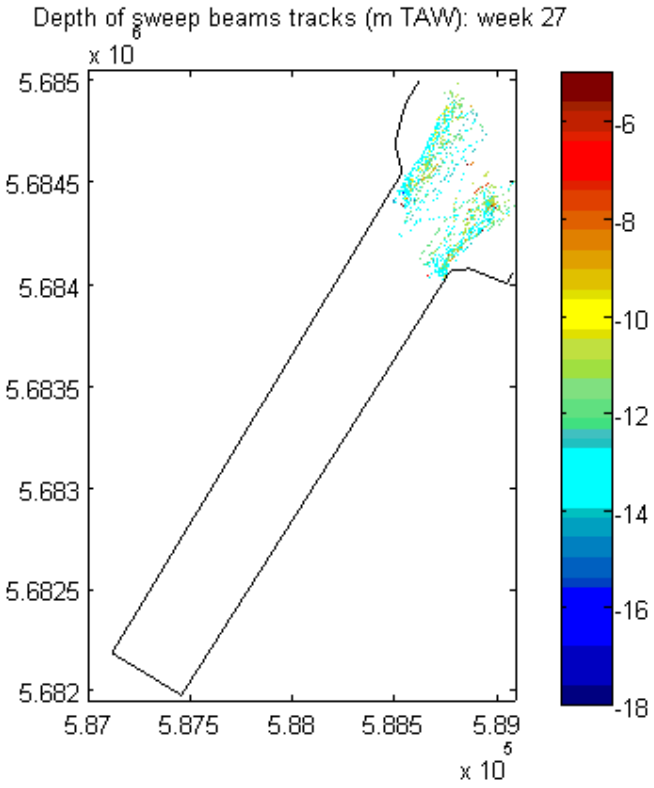
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 23
x 10^6
5.685
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 26
x 10^6
5.685
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 27
x 10^6
5.685
5.6845
5.684
5.6835
5.683
5.6825
5.682
5.87
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18